UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1998

HIGH SCHOOL APPRENTICESHIP PROGRAM FINAL REPORTS

VOLUME 12

ARMSTRONG LABORATORY

RESEARCH & DEVELOPMENT LABORATORIES

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Bolling Air Force Base

Washington, D.C.

December 1998

PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

This document is one of a set of 15 volumes describing the 1998 AFOSR Summer Research Program. The following volumes comprise the set:

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	Summer Faculty Research Program (SFRP) Reports
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REPORT DOCUMENTATIO[illegible] AFRL-SR-BL-TR-00-

0788

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December, 1998	**3.** [illegible]

4. TITLE AND SUBTITLE 1998 Summer Research Program (SRP), High School Apprenticeship Program (HSAP), Final Reports, Volume 12, Armstrong Laboratory	**5. FUNDING NUMBERS** F49620-93-C-0063
6. AUTHOR(S) Gary Moore	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Research & Development Laboratories (RDL) 5800 Uplander Way Culver City, CA 90230-6608	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Office of Scientific Research (AFOSR) 801 N. Randolph St. Arlington, VA 22203-1977	**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release	**12b. DISTRIBUTION CODE**

13. ABSTRACT *(Maximum 200 words)*

The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members (Summer Faculty Research Program, (SFRP)), graduate students (Graduate Student Research Program (GSRP)), and high school students (High School Apprenticeship Program (HSAP)) being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates, Air Force Air Logistics Centers (ALC), and other AF Laboratories. This volume consists of a program overview, program management statistics, and the final technical reports from the HSAP participants at the Armstrong Laboratory.

14. SUBJECT TERMS Air Force Research, Air Force, Engineering, Laboratories, Reports, Summer, Universities, Faculty, Graduate Student, High School Student	**15. NUMBER OF PAGES**
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
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1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The numbers of projected summer research participants in each of the three categories and SREP "grants" are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest, and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1997 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the 1990 contract, RDL (in 1993) won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

YEAR	SRP Participation, by Year			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442
1995	190	115	137	442
1996	188	109	138	435
1997	148	98	140	427
1998	85	40	88	213

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years. Since then, the number of funded positions has remained fairly constant at a slightly lower level.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 52-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous individual requesters (over 1000 annually).

RDL placed advertisements in the following publications: *Black Issues in Higher Education, Winds of Change,* and *IEEE Spectrum.* Because no participants list either *Physics Today* or *Chemical & Engineering News* as being their source of learning about the program for the past several years, advertisements in these magazines were dropped, and the funds were used to cover increases in brochure printing costs.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1998 are shown in this table.

1998 Applicants and Participants			
PARTICIPANT CATEGORY	**TOTAL APPLICANTS**	**SELECTEES**	**DECLINING SELECTEES**
SFRP	382	85	13
(HBCU/MI)	(0)	(0)	(0)
GSRP	130	40	7
(HBCU/MI)	(0)	(0)	(0)
HSAP	328	88	22
TOTAL	840	213	42

4. SITE VISITS

During June and July of 1998, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

Before 1993, an RDL program representative visited from seven to ten different HBCU/MIs annually to promote interest in the SRP among the faculty and graduate students. These efforts were marginally effective, yielding a doubling of HBCI/MI applicants. In an effort to achieve AFOSR's goal of 10% of all applicants and selectees being HBCU/MI qualified, the RDL team decided to try other avenues of approach to increase the number of qualified applicants. Through the combined efforts of the AFOSR Program Office at Bolling AFB and RDL, two very active minority groups were found, HACU (Hispanic American Colleges and Universities) and AISES (American Indian Science and Engineering Society). RDL is in communication with representatives of each of these organizations on a monthly basis to keep up with the their activities and special events. Both organizations have widely-distributed magazines/quarterlies in which RDL placed ads.

Since 1994 the number of both SFRP and GSRP HBCU/MI applicants and participants has increased ten-fold, from about two dozen SFRP applicants and a half dozen selectees to over 100 applicants and two dozen selectees, and a half-dozen GSRP applicants and two or three selectees to 18 applicants and 7 or 8 selectees. Since 1993, the SFRP had a two-fold applicant increase and a two-fold selectee increase. Since 1993, the GSRP had a three-fold applicant increase and a three to four-fold increase in selectees.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates.

SRP HBCU/MI Participation, By Year				
YEAR	**SFRP**		**GSRP**	
	Applicants	**Participants**	**Applicants**	**Participants**
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6
1995	90	21	20	8
1996	119	27	18	7

6. SRP FUNDING SOURCES

Funding sources for the 1998 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1998 SRP selected participants are shown here.

1998 SRP FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	67	38	75
USAF Laboratory Funds	17	2	13
Slots Added by AFOSR (Leftover Funds)	0	0	0
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	0	0	N/A
TOTAL	84	40	88

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

1998 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994	1995	1996	1997	1998
Faculty Members	$690	$718	$740	$740	$740	$770	$770	$793
Graduate Student (Master's Degree)	$425	$442	$455	$455	$455	$470	$470	$484
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391	$391	$400	$400	$412
High School Student (First Year)	$200	$200	$200	$200	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $52/day for faculty and $41/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 65 % claimed travel reimbursements at an average round-trip cost of $730.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-three percent (85 out of 188) of faculty associates took orientation trips at an average cost of $449. By contrast, in 1993, 58 % of SFRP associates elected to take an orientation visits at an average cost of $685; that was the highest percentage of associates opting to take an orientation trip since RDL has administered the SRP, and the highest average cost of an orientation trip.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

This is the third year of using direct deposit for the SFRP and GSRP associates. The process went much more smoothly with respect to obtaining required information from the associates, about 15% of the associates' information needed clarification in order for direct deposit to properly function as opposed to 7% from last year. The remaining associates received their stipend and expense payments via checks sent in the US mail.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1998 REPORT

The complete set of reports for the 1998 SRP includes this program management report (Volume 1) augmented by fifteen volumes of final research reports by the 1998 associates, as indicated below:

1998 SRP Final Report Volume Assignments

LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, ALCs, USAFA, WHMC	6	11	

APPENDIX A -- PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP associates represented 169 different colleges, universities, and institutions, GSRP associates represented 95 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 47 states plus Washington D.C. Selectees represent 44 states.

GSRP - Applicants came from 44 states. Selectees represent 32 states.

HSAP - Applicants came from thirteen states. Selectees represent nine states.

Total Number of Participants	
SFRP	85
GSRP	40
HSAP	88
TOTAL	213

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	83	0	83
Master's	1	3	4
Bachelor's	0	22	22
TOTAL	186	25	109

SFRP Academic Titles	
Assistant Professor	36
Associate Professor	34
Professor	15
Instructor	0
Chairman	0
Visiting Professor	0
Visiting Assoc. Prof.	0
Research Associate	0
TOTAL	85

Source of Learning About the SRP		
Category	Applicants	Selectees
Applied/participated in prior years	177	47
Colleague familiar with SRP	104	24
Brochure mailed to institution	101	21
Contact with Air Force laboratory	101	39
IEEE Spectrum	12	1
BIIHE	4	0
Other source	117	30
TOTAL	616	162

APPENDIX B – SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	100
HSAPs	75
USAF Laboratory Focal Points	84
USAF Laboratory HSAP Mentors	6

All groups indicate unanimous enthusiasm for the SRP experience.

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below:

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Faculty Associates suggest higher stipends for SFRP associates.

C. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same argument was used to raise the faculty and graduate student participation time a few years ago.)

2. 1998 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 84 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ?								(% Response)			
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	**Evals Recv'd**	**0**	**1**	**2**	**3+**	**0**	**1**	**2**	**3+**	**0**	**1**	**2**	**3+**
AEDC	0	-	-	-	-	-	-	-	-	-	-	-	-
WHMC	0	-	-	-	-	-	-	-	-	-	-	-	-
AL	7	28	28	28	14	54	14	28	0	86	0	14	0
USAFA	1	0	100	0	0	100	0	0	0	0	100	0	0
PL	25	40	40	16	4	88	12	0	0	84	12	4	0
RL	5	60	40	0	0	80	10	0	0	100	0	0	0
WL	46	30	43	20	6	78	17	4	0	93	4	2	0
Total	**84**	**32%**	**50%**	**13%**	**5%**	**80%**	**11%**	**6%**	**0%**	**73%**	**23%**	**4%**	**0%**

LFP Evaluation Summary. The summarized responses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5 a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
   b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:
13. a. Quality of RDL's communications with you:
    b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Table B-3. Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*USAFA*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	0	7	1	14	5	0	46
Question #							
2	-	86 %	0 %	88 %	80 %	-	85 %
2a	-	4.3	n/a	3.8	4.0	-	3.6
2b	-	4.0	n/a	3.9	4.5	-	4.1
3	-	4.5	n/a	4.3	4.3	-	3.7
4	-	4.1	4.0	4.1	4.2	-	3.9
5a	-	4.3	5.0	4.3	4.6	-	4.4
5b	-	4.5	n/a	4.2	4.6	-	4.3
6a	-	4.5	5.0	4.0	4.4	-	4.3
6b	-	4.3	n/a	4.1	5.0	-	4.4
6c	-	3.7	5.0	3.5	5.0	-	4.3
7a	-	4.7	5.0	4.0	4.4	-	4.3
7b	-	4.3	n/a	4.2	5.0	-	4.4
7c	-	4.0	5.0	3.9	5.0	-	4.3
8	-	4.6	4.0	4.5	4.6	-	4.3
9	-	4.9	5.0	4.4	4.8	-	4.2
10a	-	5.0	n/a	4.6	4.6	-	4.6
10b	-	4.7	5.0	3.9	5.0	-	4.4
11	-	4.6	5.0	4.4	4.8	-	4.4
12	-	4.0	4.0	4.0	4.2	-	3.8
13a	-	3.2	4.0	3.5	3.8	-	3.4
13b	-	3.4	4.0	3.6	4.5	-	3.6
14	-	4.4	5.0	4.4	4.8	-	4.4

3. 1998 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 120 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from 1 (below average) to 5 (above average) - by Air Force base results and over-all results of the 1998 evaluations are listed after the questions.

1. The match between the laboratories research and your field:
2. Your working relationship with your LFP:
3. Enhancement of your academic qualifications:
4. Enhancement of your research qualifications:
5. Lab readiness for you: LFP, task, plan:
6. Lab readiness for you: equipment, supplies, facilities:
7. Lab resources:
8. Lab research and administrative support:
9. Adequacy of brochure and associate handbook:
10. RDL communications with you:
11. Overall payment procedures:
12. Overall assessment of the SRP:
13.
    a. Would you apply again?
    b. Will you continue this or related research?
14. Was length of your tour satisfactory?
15. Percentage of associates who experienced difficulties in finding housing:
16. Where did you stay during your SRP tour?
    a. At Home:
    b. With Friend:
    c. On Local Economy:
    d. Base Quarters:
17. Value of orientation visit:
    a. Essential:
    b. Convenient:
    c. Not Worth Cost:
    d. Not Used:

SFRP and GSRP associate's responses are listed in tabular format on the following page.

Table B-4. 1997 SFRP & GSRP Associate Responses to SRP Evaluation

	Arnold	Brooks	Edwards	Eglin	Griffis	Hanscom	Kelly	Kirtland	Lackland	Robins	Tyndall	WPAFB	average
# res	6	48	6	14	31	19	3	32	1	2	10	85	257
1	4.8	4.4	4.6	4.7	4.4	4.9	4.6	4.6	5.0	5.0	4.0	4.7	4.6
2	5.0	4.6	4.1	4.9	4.7	4.7	5.0	4.7	5.0	5.0	4.6	4.8	4.7
3	4.5	4.4	4.0	4.6	4.3	4.2	4.3	4.4	5.0	5.0	4.5	4.3	4.4
4	4.3	4.5	3.8	4.6	4.4	4.4	4.3	4.6	5.0	4.0	4.4	4.5	4.5
5	4.5	4.3	3.3	4.8	4.4	4.5	4.3	4.2	5.0	5.0	3.9	4.4	4.4
6	4.3	4.3	3.7	4.7	4.4	4.5	4.0	3.8	5.0	5.0	3.8	4.2	4.2
7	4.5	4.4	4.2	4.8	4.5	4.3	4.3	4.1	5.0	5.0	4.3	4.3	4.4
8	4.5	4.6	3.0	4.9	4.4	4.3	4.3	4.5	5.0	5.0	4.7	4.5	4.5
9	4.7	4.5	4.7	4.5	4.3	4.5	4.7	4.3	5.0	5.0	4.1	4.5	4.5
10	4.2	4.4	4.7	4.4	4.1	4.1	4.0	4.2	5.0	4.5	3.6	4.4	4.3
11	3.8	4.1	4.5	4.0	3.9	4.1	4.0	4.0	3.0	4.0	3.7	4.0	4.0
12	5.7	4.7	4.3	4.9	4.5	4.9	4.7	4.6	5.0	4.5	4.6	4.5	4.6
Numbers below are percentages													
13a	83	90	83	93	87	75	100	81	100	100	100	86	87
13b	100	89	83	100	94	98	100	94	100	100	100	94	93
14	83	96	100	90	87	80	100	92	100	100	70	84	88
15	17	6	0	33	20	76	33	25	0	100	20	8	39
16a	-	26	17	9	38	23	33	4	-	-	-	30	
16b	100	33	-	40	-	8	-	-	-	-	36	2	
16c	-	41	83	40	62	69	67	96	100	100	64	68	
16d	-	-	-	-	-	-	-	-	-	-	-	0	
17a	-	33	100	17	50	14	67	39	-	50	40	31	35
17b	-	21	-	17	10	14	-	24	-	50	20	16	16
17c	-	-	-	-	10	7	-	-	-	-	-	2	3
17d	100	46	-	66	30	69	33	37	100	-	40	51	46

4. 1998 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

Not enough evaluations received (5 total) from Mentors to do useful summary.

5. 1998 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 23 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from 1 (below average) to 5 (above average)

1. Your influence on selection of topic/type of work.
2. Working relationship with mentor, other lab scientists.
3. Enhancement of your academic qualifications.
4. Technically challenging work.
5. Lab readiness for you: mentor, task, work plan, equipment.
6. Influence on your career.
7. Increased interest in math/science.
8. Lab research & administrative support.
9. Adequacy of RDL's Apprentice Handbook and administrative materials.
10. Responsiveness of RDL communications.
11. Overall payment procedures.
12. Overall assessment of SRP value to you.
13. Would you apply again next year? Yes (92 %)
14. Will you pursue future studies related to this research? Yes (68 %)
15. Was Tour length satisfactory? Yes (82 %)

	Arnold	Brooks	Edwards	Eglin	Griffiss	Hanscom	Kirtland	Tyndall	WPAFB	Totals
# resp	5	19	7	15	13	2	7	5	40	113
1	2.8	3.3	3.4	3.5	3.4	4.0	3.2	3.6	3.6	3.4
2	4.4	4.6	4.5	4.8	4.6	4.0	4.4	4.0	4.6	4.6
3	4.0	4.2	4.1	4.3	4.5	5.0	4.3	4.6	4.4	4.4
4	3.6	3.9	4.0	4.5	4.2	5.0	4.6	3.8	4.3	4.2
5	4.4	4.1	3.7	4.5	4.1	3.0	3.9	3.6	3.9	4.0
6	3.2	3.6	3.6	4.1	3.8	5.0	3.3	3.8	3.6	3.7
7	2.8	4.1	4.0	3.9	3.9	5.0	3.6	4.0	4.0	3.9
8	3.8	4.1	4.0	4.3	4.0	4.0	4.3	3.8	4.3	4.2
9	4.4	3.6	4.1	4.1	3.5	4.0	3.9	4.0	3.7	3.8
10	4.0	3.8	4.1	3.7	4.1	4.0	3.9	2.4	3.8	3.8
11	4.2	4.2	3.7	3.9	3.8	3.0	3.7	2.6	3.7	3.8
12	4.0	4.5	4.9	4.6	4.6	5.0	4.6	4.2	4.3	4.5
Numbers below are percentages										
13	60%	95%	100%	100%	85%	100%	100%	100%	90%	92%
14	20%	80%	71%	80%	54%	100%	71%	80%	65%	68%
15	100%	70%	71%	100%	100%	50%	86%	60%	80%	82%

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

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Final Report for:
High School Apprenticeship Program
AFRL/Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Armstrong Laboratory

August 1998

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

Michael G. Anderson

The University of Texas at Austin

Abstract

Induced transmittance of laser eye protection served as the research focal point. Twelve samples of Laser Eye Protection (LEP) underwent tests to detect induced transmittance. The laser configuration delivered ultrashort pulses at 800nm to the samples. Energy generally varied from 5.0E-8 to 6.0E-5 Joules and pulses were typically in the 90 - 130 femtosecond range. The experimental results revealed that no samples exhibited induced transmittance with satisfactory certainty. Some examples did show a decreasing pattern of optical density, but the variation in optical density was insignificant.

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

Michael G. Anderson and Charles H. Mims

I. Introduction

Recent revolutionary developments in LASER (Light Amplification by Stimulated Emission of Radiation) technology have prompted the need for research and development of laser eye protection (LEP). High intensity laser beams can cause visible lesions and even hemorrhages on the retina of the eye. As a result of the increased use of lasers in the battlefield, the military sponsored research to improve laser eye protection. Current laser eye protection can significantly reduce the transmittance of selective wavelengths of light. However, after testing LEPs at the femtosecond (10^{-15}) range, a phenomenon known as induced transmittance or "bleaching" was discovered. Bleaching occurs at ultrashort pulses when the absorptive material in the LEP cannot absorb the laser beam fast enough to prevent transmittance. Bleaching has become a major issue in the field of laser research. Many manufacturers of laser eye protection have stopped production of LEPs based on the discovery of bleaching effects at the ultrashort range. The halt on production was ill advised because laser eye protection is still effective against laser radiation at the non – ultrashort range. Our research concentrated on LEP bleaching at the 800nm wavelength. The experimentation continued the research of several pioneers of this field at the Air Force Research Laboratory, Armstrong Research sight.

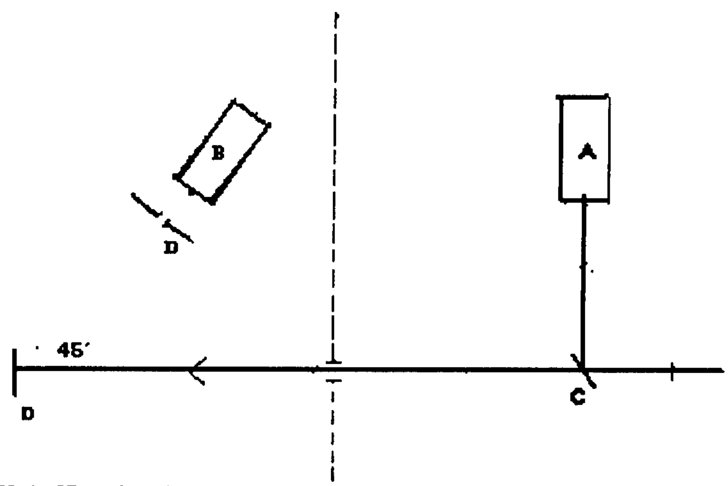
Experimental Procedure

The first step of the experiment involved intense research into laser technology. We were briefed on laser safety and how to correctly operate the lasers. The first days in the lab involved familiarization with the lab equipment.

The next part involved the construction of a "light proof" optical enclosure. This enclosure was created to block out stray light from the detectors. Corrugated black plastic board served as the walls of the enclosure. The dimensions were 16" wide, 24" long, and 10" high. This completely surrounded the optical breadboard with a 4" width overhang for more detector space. Black felt lined the inside of the box to help ensure the least amount of possible light entrance. After the construction of the optical enclosure, the samples of laser eye protection were catalogued. Optical elements were aligned on the optical table to direct the beam into the optical enclosure. The setup was then aligned with a Helium Neon laser.

Data collection began with the calibration of the two detectors. The calibration of the detectors without a filter in the beam path of either detector presented an accuracy problem. Prior to our experiment, Ben Rockwell already solved this problem with the patented setup described below.

II. Calibration Setup



A: Detector J3-09 #451 (calibration date 2-28-98)

B: Detector J3S-10 #0538D98

C: Beam Splitter (80% transmission, 20% reflection) UT-800-20-45-UNP

D: Diffusion Plate (k = 0.514) labsphere REP#8433-1-2

E: Aperature, r = 1.2mm

D->E: 156mm

E->B: 58mm

*** the dotted line represents a separation board within the setup enclosure**

**** an 800nm filter was fixed to the front of the J3S throughout the experiment**

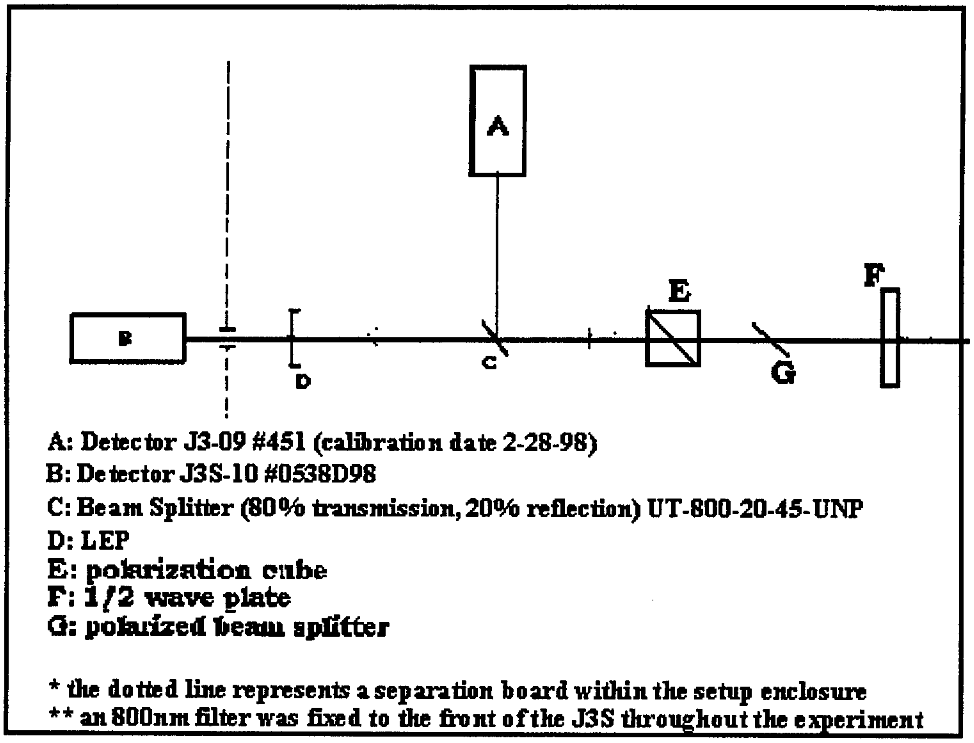
To calibrate the J3S detector, we used a technique for creating a known optical density that is described by the equation

$$OD = -LOG10((K * s * \cos\Theta) / \pi R^2)$$

Our setup included a diffusion plate with the reflective constant K = 5.14, an aperture area, s = 1.2mm^2, an angle, $\theta = 45°$ and a distance from diffusion plate to aperture, R = 156mm. The ideal OD according to this model is then 4.67.

Initially, our energy results did not conform to this model. We determined that because the polarization of the beam was not consistent as the pulse energy was varied, the beam splitter within our experiment did not have reliable beam splitter ratios for each pulse. A polarization cube placed in the beam path before the beam splitter corrected this problem. Ultimately, the ratio was determined to be a factor of 2.3 so that with data from detectors A (J3) and B (J3S) the optical density could be determined as
OD = -LOG10(B/(A*2.3))

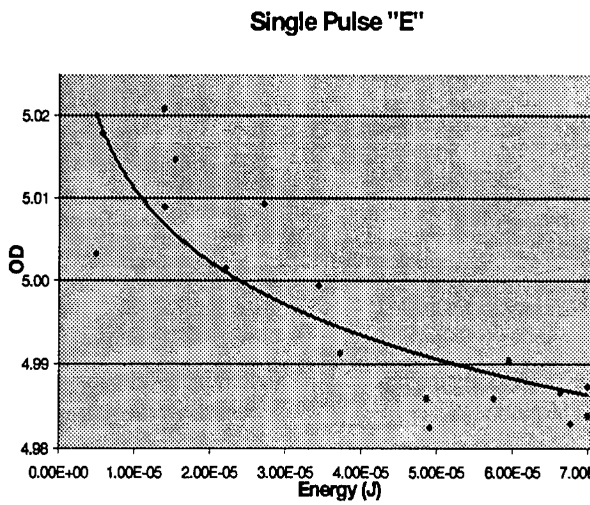
III. Experimental Setup

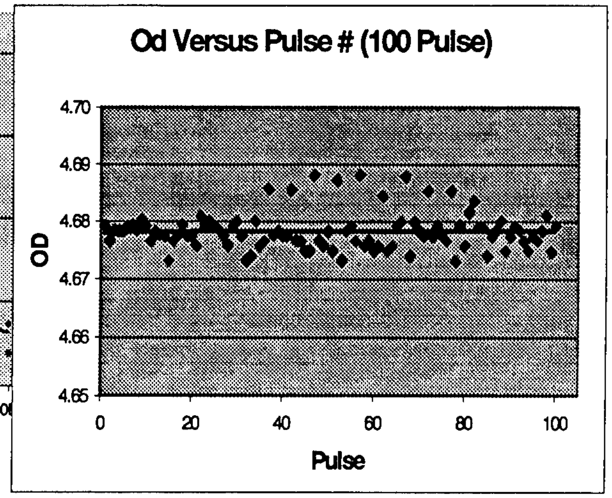


After calibrating the detectors, we determined the standard optical density for the setup (this step was done daily). Then we determined a method of securing the LEP samples in a constant position that was normal to the beam. The LEPs were held in place with a three-prong test tube clamp. Hole-punch reinforcement-style stickers were placed on the LEP. First, they insured that the same point on the LEP was hit with each set of pulses. Secondly, they marked the point of impact for microscopic inspection. The illustration above shows our setup.

The laser beam energy was controlled using a half wave plate and polarized beam splitter attenuator. Also, a polarizing cube was placed in the beam path to reduce the effect that varying energy had on the beam splitter within the setup. Preliminary calibration showed that the cube increased our data reliability by a significant figure.

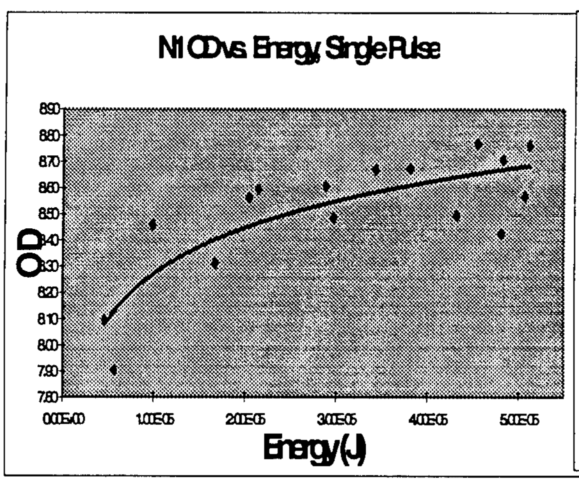
Data was recorded for all samples in sets of single pulses and 100 pulses with a 5° rotation of the wave plate between each shot (240° - 205°). For the multiple pulse readings, we used LabVIEW for Windows to record the data. Gary Noojin programmed a Virtual Instrument with this software. Through computer interface with data acquisition boards, the time required to collect the data was drastically reduced.

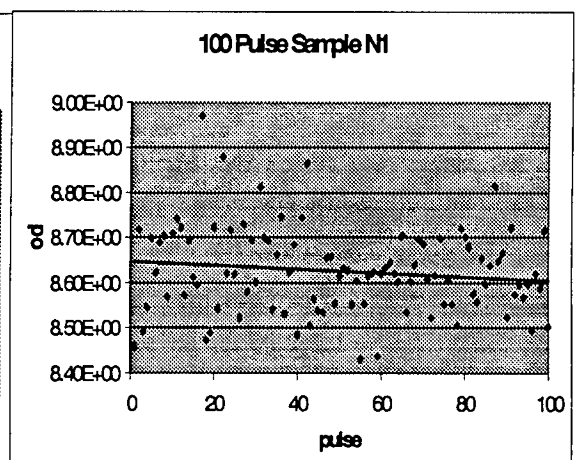




IV. Data Analysis

Sample "E" above exhibited unexpected results. At single pulses, the sample showed a slight bleaching trend. However, at 100 pulses, the optical density versus pulse number increased slightly. The results are probably accurate, but any miscalculation could be attributed to several possible sources of error. First of all, when calibrating the detectors, slight errors would have drastically affected the results. Detector B measures energy transmitted through the LEP and operates near the noise floor during high OD measurements. Fluorescence off the LEP could have altered the measurements. Also, when using LabVIEW, the precision of the measurements was often less than desirable (unnoticed until after readings were made). The readings could have been close to the noise floor of the detectors. This would have given incorrect energy readings. If all readings are correct, this data might suggest that the minor bleaching trend on the single pulse sample changed the physical or chemical properties of the sample. A change in





attributes of the sample could have produced unpredictable results in the 100 pulse readings.

"N1" was one of the two samples that showed physical damage from the laser. Multiple orange abrasions appeared on the surface of the LEP in the testing region. No similar abrasions were found on the unexposed area. The average width of the abrasions was about 6 microns. This sample increases in optical density versus energy on single pulses. With 100 pulses, this sample shows a minor decrease in optical density versus pulse number. The curve on the 100-pulse graph is fairly unreliable because of the wide point scatter. Many of the 100 pulse graphs revealed the same wide point scatter.

Test Results per Sample

		Increasing, Decreasing, or Static OD?			(Physical Change?)
sample	**Description**	**OD @ 800nm**	**Single Pulse**	**100 Pulse # vs. OD**	**Comments**
E	Grn plastic	5.00	decreasing	Increasing	major shift
G	Bg42 1mm	4.68	static	Static	glass samples
H	Bg42 2mm	6.96	static	Static	glass samples
K	Grn pl (visor type)	N/A	N/A	Increasing	
N1	Sample 1 - purp pl	8.55	static	Increasing	damage spots from laser
N2	Sample 2 - purp pl	8.71	static	Increasing	damage spots from laser
N3	Sample 3 - purp pl	7.93	static	Static	
N4	Sample 4 - purp pl	8.06	static	Increasing	
N5	Sample 5 - purp pl	4.80	decreasing	Decreasing	
N6	Sample 6 - purp pl	4.62	decreasing	Decreasing	
Q	Drk purp pl laser shield	6.72	decreasing	Static	
R	Brwn pl laser shield	5.04	increasing	Increasing	

These two data sets represent typical experimental results of all 12 samples. It also shows the trends of optical density versus pulse number at 100 pulses.

V. Conclusion

Samples "E", "N5", "N6", and "Q" showed decreasing optical density versus energy at single pulses. However, this decrease in optical density was not significant enough to qualify as bleaching. Samples "E", "K", "N1", "N2", "N4", and "R" showed an increase in optical density versus pulse number. Only "N1" and "N2" showed physical damage caused by the laser. The irradiance of our laser beam was significantly lower than that of other peoples' experiments that did experience bleaching. Our experimentation revealed more information on the topic of induced transmittance. A few of the samples showed a decrease in optical density versus energy, but no sample showed dramatic bleaching effects. Further research on this phenomenon is recommended with studies to compare irradiance levels. Hopefully, this type of research will lead to the creation of LEPs that can protect individuals from ultrashort pulses.

We give special thanks to the members of the Optical Radiation Branch of the Air Force Research Laboratory, Brooks AFB, for their support and insight. Especially Gary Noojin, Dave Stolarski, Major Gordon Hengst, and Dr. Benjamin Rockwell for their help in operating the femto–second laser system and assistance in data collection. Their guidance and assistance insured a successful experiment.

Jacob Blumberg's report was not available at the time of publication.

REALISTICALLY DUPLICATING THE APPEARANCE AND INTERFACE OF ACTUAL UAV DEMPC EQUIPMENT ON A DESKTOP PC

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Final Report For:
High School Apprentice Program
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August 1998

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Abstract

Study was focused on the task of duplicating the mission planning interface of the existing Uninhabited Aerial Vehicle (UAV). The controls of the interface were first studied, and then guidelines were drawn out to ensure key elements were maintained. A program was then written on a desktop PC which mimicked the basic behavior of the DEMPC (Data Exploitation Mission Planning Communication) station. This basic model was then expanded to incorporate all aspects of the actual DEMPC station. Each individual element was added so that it closely resembled the actual control interface. The end result was an accurate model of the existing interface which will be used in studies of how to improve both efficiency and ease of use. This task will likely yield excellent results due in part to the efforts made toward maintaining a close resemblance to actual equipment.

REALISTICALLY DUPLICATING THE APPEARANCE AND INTERFACE OF ACTUAL UAV DEMPC EQUIPMENT ON A DESKTOP PC

John T. Hereford

Much of the high tech equipment used today is specifically catered to perform one task, or tasks which are all very similar. Some of this specialized equipment is extremely expensive, operating costs are high, and often these tasks take a lot of time to complete. Efforts are constantly being made to reduce the amount of time and money which must be spent on the operation of this equipment without sacrificing the quality of the task performed. One of the easiest means of achieveing this is through the use of simulations. Simulations can cut costs in a variety of ways. They can be used as consideration during product development, to ensure efficient design, and they can also be used as a tool in training the operators of the actual devices. By using accurate simulations in conjunction with the actual equipment, a countless amount of money can be saved. But the actual development of a simulator requires large amounts of detail, and tedious work to ensure accuracy to actual equipment.

This was the basic task which was set out during my summer apprenticeship at Armstrong labs. Specifically, to create a simulation of a DEMPC (Data Exploitation Mission Planning Communication) station which would run on a desktop PC. The DEMPC station is used to plan the flight path of a UAV (Uninhabited Aerial Vehicle), by designating individual targets and the flight path which should be taken by the vehicle. This would be accomplished through the use of Borland Delphi Developer 3.0, a rapid application development language which is based on Borland Pascal. The entire simulation was overseen by the task scientist, who was responsible for providing the guidelines which were followed to simulate the actual DEMPC station. Among the specific aspects needed to accurately simulate the DEMPC station, the program had to allow the user access to three different interface pages, the mission planning screen, the mission monitor screen, and a third page which would provide the user with information about the targets. While an information page is not actually found on DEMPC stations, is was added in the simulation to convey information which would normally be received through other means, i.e. radio communication, mission briefings, etc.

The mission planning page was the most detailed and allowed the most interaction with the user. This was the page that would be used to place collection points over those targets which would be photographed. For each of the collection points, the user needed to designate both the altitude and speed of the UAV as it passed through that spot. Once the photograph collection spots were placed, the path between them and the order in which the targets would be photographed had to be set. All of this had to be done with the same basic format of the DEMPC station. The mission planning page also had to convey a variety of information back to the user. Just like actual DEMPC stations, the simulator gave wind speed and direction, cloud conditions, starting and ending points, any important terrain features, and the area in which the UAV was allowed to fly. The station's interface also provided information about the path as it was planned, such as length, estimated time, and estimated fuel usage. All of this was completed to match the description detailed in the provided guidelines.

This was accomplished first by setting up a simple image which would respond when it was clicked on with the mouse. Then a map was placed in the image to simulate the actual map on a DEMPC screen. The targets were read in from a source file which contained all the information about the particular mission which was running. After the simulation got the information about the targets, they could be placed in their appropriate positions on the map. The next step was programming the simulation to allow the user to place collection points over the targets which would be photographed. Once the simulation could place collection points, it required options which allowed the user to enter the altitude and speed that the UAV would have as it passed through each point. Once all of the collection points could be set, the flight path needed to be laid out. To accomplish this two collection points would be selected by the user, and the simulator would generate a line representing a straight path between the two points. The user could then change the straight path by setting way points which the UAV would have to fly through. As each way point was set, the simulation would again have them enter an altitude and a speed for the UAV. By doing this the path could be set to go around terrain features, or no-fly zones. Once all of the collection points were connected, the user could send the mission, and observe its progress through the mission monitor page.

The mission monitor page is another example of how simulations can save time and money. Instead of taking several hours to fly along a designated flight path, the simulation was able to incorporate a flight model to simply predict how much fuel and time were consumed. This allowed all of the people who used the simulator to complete missions in a short amount of time. The simulator also allowed for real world occurrences, such as clouds covering a target, or a target being hidden from view by some obstruction. Whenever such an event would occur, the simulation would pause and give the user similar options to what there would be on an actual DEMPC station. The mission could be re-planned, by returning to the mission planning screen, the user could instruct the UAV to loiter in the area, to find an opening in the clouds or to circle around to the other side of a target, or the user could simply instruct the UAV to move on to the next target, if the vehicle were to be running out of fuel or time. The mission monitor screen also had to be capable of displaying the flight path in different colors, to indicate what leg the UAV was currently on, which leg(s) have already been flown and were not able to be changed, and which leg(s) were planned but were still uncompleted. Another important feature of the mission monitor page is that it shows the user exactly how much fuel and time are remaining, so that at any time, changes can be made to ensure the UAV will make it to the exit point before it is too late. While the mission monitor screen might not have the same amount of interface as the mission planner, it was much more intensive to convert to the desktop PC format. Much of the programming for the mission monitor screen had to be created from scratch, because there was no equivalent in the DEMPC station.

The third screen, the information page, could be accessed from either the mission monitor or planning screen. The page allowed very little interface with the user, and its only real purpose was to provide the user with important information about the mission. Included on the information screen was the allotted time for the mission, and target information such as priority, visibility, description, and current status of the target. All of this information had to be read in from a separate file so that each mission would have a unique set of targets with a specific reasoning behind their placement, and not just randomly generated locations. Also, the information had to be updated when the user triggered certain events. For example, when the user photographed a target, the target's status would change to an "S" to indicate that it was satisfied. The information page was not as complicated as the other pages, because it had only one general function. In addition, it took less effort to program since there was no exact DEMPC format which had to be followed.

The actual programming of both the planning and the monitor pages required an extra effort because the specific DEMPC format had to be followed. To properly accomplish this some work had to be done so that the Delphi programming environment would produce something which appeared to come from a different format. Fortunately, Delphi allows easy access to the low level calls which make up Windows through a programming technique called "wrapping". Wrapping is where low level calls are placed inside procedures which can then be used in place of the low level language. This was necessary when the map interface was created. In order to determine the exact point on the map where the user clicked, one of the Delphi "wrappers" was used to figure out where the mouse was, and was then used to convert that position into a relationship with the map. Through this method, points could be placed anywhere on the map, regardless of where the targets were or where the map was on the screen. This enabled the same flexible interface which is found in the DEMPC stations.

Another aspect of the simulation which took some effort to reproduce was the procedure which drew the lines representing the flight path. In the actual DEMPC station each way point must be assigned to a specific collection point. This is done to ensure that the path of the UAV can cross over the path to different collection points without deviating toward other way points along the different paths. The simulation for the DEMPC had to be capable of the same function. Each way point was assigned to both the collection point before it and after it, so that the flight path could only go between the collection points which were designated for that leg. This problem escalated when multiple way points were placed along the same leg. An algorithm had to be integrated into the program so that way points were not traveled to in the order they were placed down. Instead, each point would lead to the point it was closest to, allowing any possible flight path to be placed into the simulator with very little effort or confusion.

The simulation also needed to include the option to delete points after they had been placed. In addition, whenever a point was going to be deleted, the user would be given the option to delete just that point, or the entire leg that point was on. This caused some complications, because all of the points following the one which had been deleted had to be changed to act as though the point was never there. Otherwise, all of the way points would cycle through to a different leg of the flight path, because they were assigned to certain collection points based on an index. Every time a point was deleted, the index would change, and an algorithm would have to be run to update the way points so that they remained on the proper flight path.

After the mission was completely planned and sent, the path for the UAV would have to be recorded on a separate index, so that the progression of the UAV could be recorded. As the flight simulation progressed, the targets assigned to the current collection point would have to be checked in order to determine what message to send to the user. The messages could range from a simple "Target satisfied" to several error messages, some of which couldn't be fixed, such as "Target no longer available". In order to do this successfully, the new index recorded which of the collection points had been visited, and which were left to be visited and in what order. This allowed the targets not give messages no matter what order they were reached in. Not only did the second index help with viewing targets, but it also helped with displaying the different legs in the appropriate colors. The simulation could only draw the legs in the order that they were originally given to the computer, not the order the flight path took. Due to this, as the simulation drew each leg it also checked the second index to determine which color to use for the current leg it was drawing. The second index turned out to be a necessity for the simulation to run correctly.

After the simulation was capable of running in a similar manner to the actual DEMPC station, one additional feature had to be added to properly perform the task it was planned to do. Since the DEMPC simulator was going to be used as a test for prospective operators of the actual DEMPC station, it had to be able to record what users did. As various people used the simulator, their individual results had to be stored for later use. The simulator took advantage of some features found in the Delphi 3.0 environment to properly accomplish this task. As each session ended, the simulator took all of the information which was unique to that run of the program and recorded it onto a format compatible with the desktop PC on which it ran. This allowed the task scientists easy access to all of the information they required to analyze the responses of each individual. While the simulator had not been tested on any subjects as of the writing of this report, it already records all of the responses given during trial runs of the program.

The simulation of the DEMPC produces an interface which very closely resembles the actual DEMPC user interface. Because the simulation is specifically written for a desktop PC format, it can be transferred to as many different computers as necessary. This will allow easy, quick and cheap training for future DEMPC operators, as well as an idea to those in training about what the actual DEMPC station will be like. The simulator is by no means perfect however. It lacks many features which are just not transferable to the PC. Users cannot get a view from a camera on the actual UAV, they cannot get a real feel for the speed and performance of the UAV, and they cannot actually experience a real mission, only pre-planned situations. The simulator can in no way compare to the actual operation of a DEMPC station, but for simple tests it can prove far more effective. The simulator will save time and money by allowing anyone to run through the same interface, without the actual costs or time requirements of running a real UAV on a real DEMPC station.

A STUDY IN THE SELECTIVE HEATING OF THE RAT ANATOMY

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Final Report for:
High School Apprenticeship Program
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Sponsored by:
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August 1998

A STUDY IN THE SELECTIVE HEATING OF THE RAT ANATOMY

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Abstract

A method by which to selectively heat a specific part of the rat brain, while maintaining a normal core temperature, was studied. The results of this study are to be implemented in an exercise experiment involving rats and the correlation between brain temperature and exhaustion. To accomplish this kind of selective heating, a probe was designed to be inserted into the hypothalamic region of the rat's brain and to heat that area without raising the rat's core temperature. Hot water circulated through the probe provided the necessary heat to raise the brain temperature to 42°C, which had been noted in previous experiments to be the temperature threshold of exhaustion. While maintaining body temperature at normal levels, the sole effect of brain temperature upon fatigue in rats can be observed.

A STUDY OF THE SELECTIVE HEATING OF THE RAT ANATOMY

Kathleen Kao

Introduction

In previous experiments, exhaustion in rats has been hypothesized to be linked to hypothalamic temperatures. It has been observed that rats express signs of fatigue when hypothalamic temperatures reach the vicinity of 42.1°C (Walters et al, 1998). In such experiments, the rat's brain temperature was rapidly raised by exposure to microwaves. The rat was then run on the treadmill to exhaustion. However, in heating the rat's brain, the microwaves also raised the rat's core temperature to approximately the same range as its hypothalamic temperature. This posed the important question of whether it was the increase in hypothalamic temperature or core temperature that was the predominant factor in the induction of fatigue. The purpose of the present project is to devise a method in which the rat's brain can be heated to temperatures previously noted to cause fatigue, while the rat's body temperature remains normal, by inserting a probe into the rat's hypothalamus and circulating hot water through the probe. The main aspects this study concentrated on were determining the rate of water flow through the probe, the rate of heating occurring in the brain, and the temperature the water must be to maintain hypothalamic temperatures in excesses of 42°C. This method will be utilized in the continuation of the exhaustion study.

Methodology

The probes, which functioned primarily to measure temperature and circulate water, were made using assorted tubing and catheters. Two catheters were sealed together with epoxy; one catheter, approximately 7.2 mm long, functioned as a temperature guide, in which a Vitek probe would be inserted, while the other, approximately 4.8 mm long, provided continuous water flow (see Fig. 1). Silastic tubing was connected to

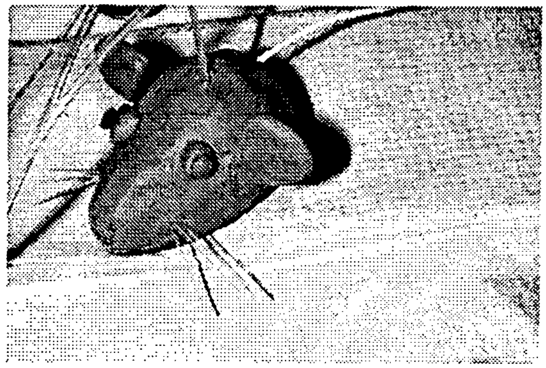


Fig. 1

Clay rat head with probes

the water flow catheter. The free end of the tubing was placed in a hot water bath, and drew heated water into the probe. A piece of fused silica, about 5.6 mm long, was inserted into the catheter by piercing the wall of the silastic tubing near its conjunction with the catheter, and eased down the length of the catheter, leaving about a millimeter of space between the tip of the fused silica and the end of the catheter. The hot water flowed out through the fused silica before given the chance to stagnate at the bottom of the catheter and cool, therefore counteracting the effects of fresh hot water entering the probe. PE-50 tubing was then attached to the protruding end of the fused silica and connected to a piece of low volume connector tubing with another short strip of fused silica. The connector tubing was then fastened to a swivel to allow the rat freedom to move its head during the actual experiment. The swivel was connected to another length of PE-100 tubing, which acted as a disposal conduit for the cooler water that circulated out of the probe.

Prior to surgery, each of the four rats in this study was anesthetized with Urethane and shaved over the skull area. The rat was then placed in the stereotaxic device for rodent surgery (see Fig. 2). Stereotaxic surgery was performed on each rat to implant the probe in the hypothalamic region of the rat's brain (see Fig. 3). Another temperature probe was inserted approximately 5 mm away from the first, along the

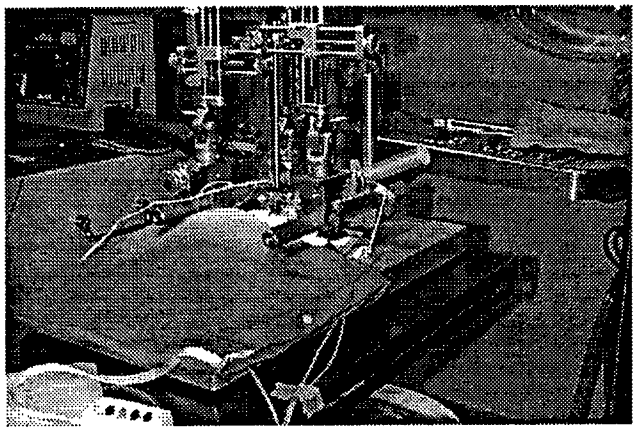


Fig. 2

Rat, lying under blue heating pad, connected to
stereotaxic device, next to water bath

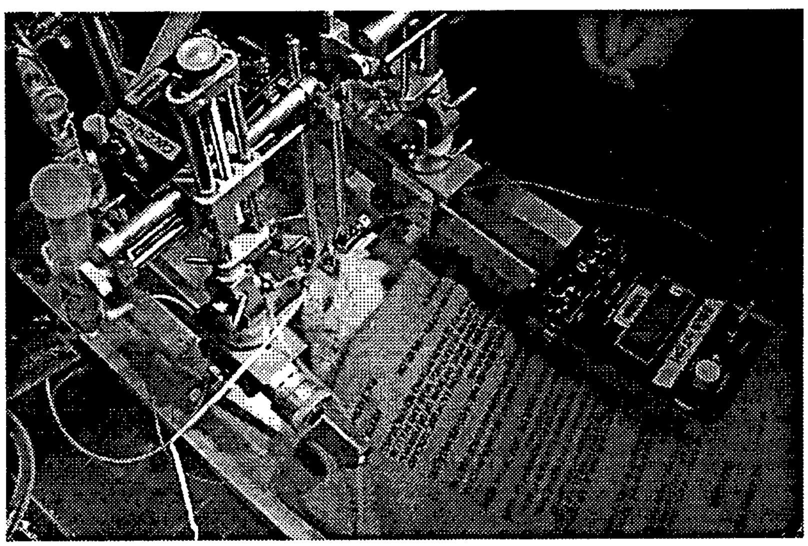


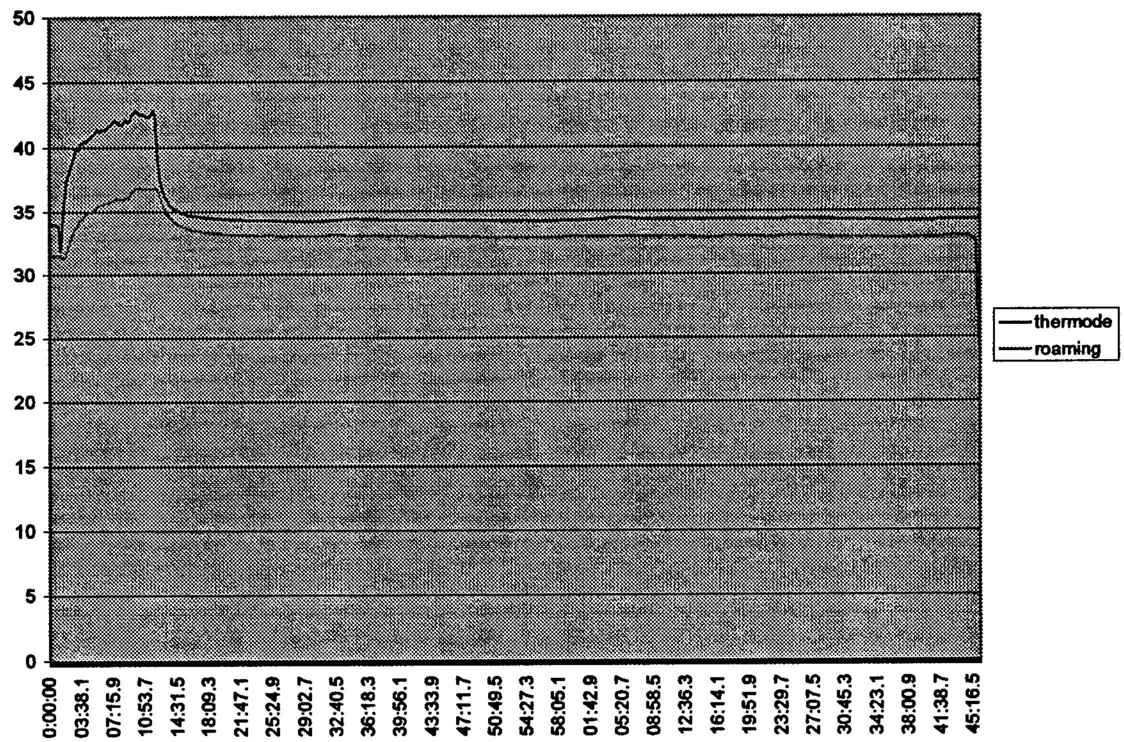
Fig. 3

Probes being lowered into rat's exposed skull sagittal suture, to measure the amount of heat radiating outward from the original probe. A rectal probe was also inserted. To maintain a normal core temperature (approximately 37°C) the rat was kept warm with a heating pad. All three temperature probes, the one in the catheter (the thermode), the one situated towards the back of the brain along the sagittal (the roaming), and the rectal, were inputted into a computer which continuously recorded data throughout the duration of the surgery. After all probes had been inserted hot water was allowed to flow through the tubing and heat up the rat's hypothalamus. The water temperature was adjusted according to the thermode reading given by the computer. The water flow was turned off and on periodically to maintain a steady brain temperature of approximately 42°C.

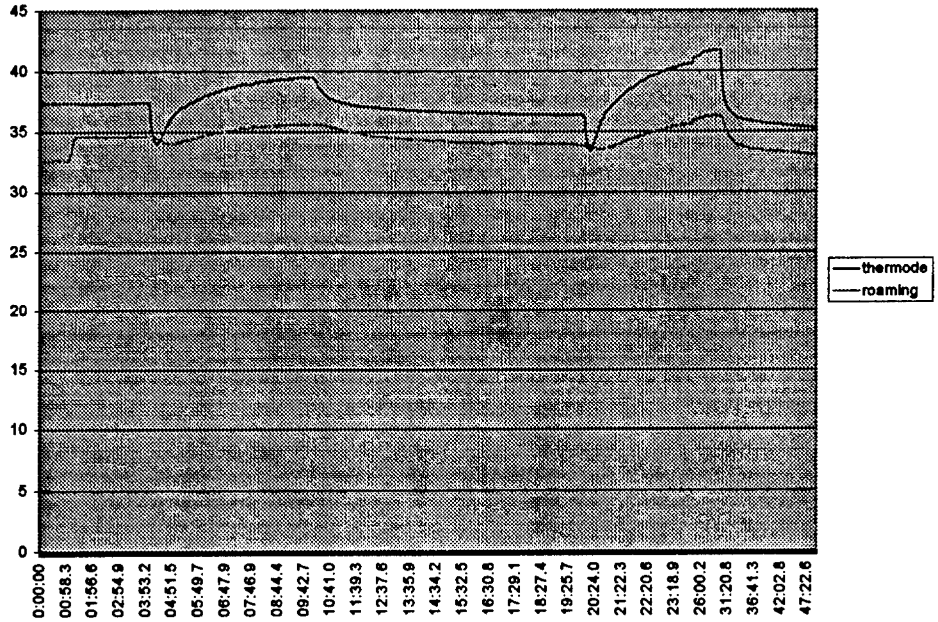
Results

The water bath provides a maximum water flow of approximately 5 ml/min. It was empirically determined that a greater amount of water pressure would place undue stress on the tubes transporting the water and possibly disrupt them. To raise hypothalamic temperature to 42°C, the ideal brain temperature for this experiment, the water bath was maintained at about 80°C. The ideal hypothalamic temperature could be achieved within 4 to 5 min. However, it was also found that the brain would regulate its temperature remarkably well and would not heat up in excess of seven degrees at a time. Therefore, it was occasionally necessary to first course some hot water through the probes prior to the actual collection of the data to heat the brain a little. Hot water was allowed to run through the probe until the hypothalamic temperature reached between 36°C or 37°C, and then was evacuated from the tubes, creating a vacuum, so that fresh hot water entering the tubes could immediately heat up the hypothalamus without being hindered by the presence of cooler water in the tubes.

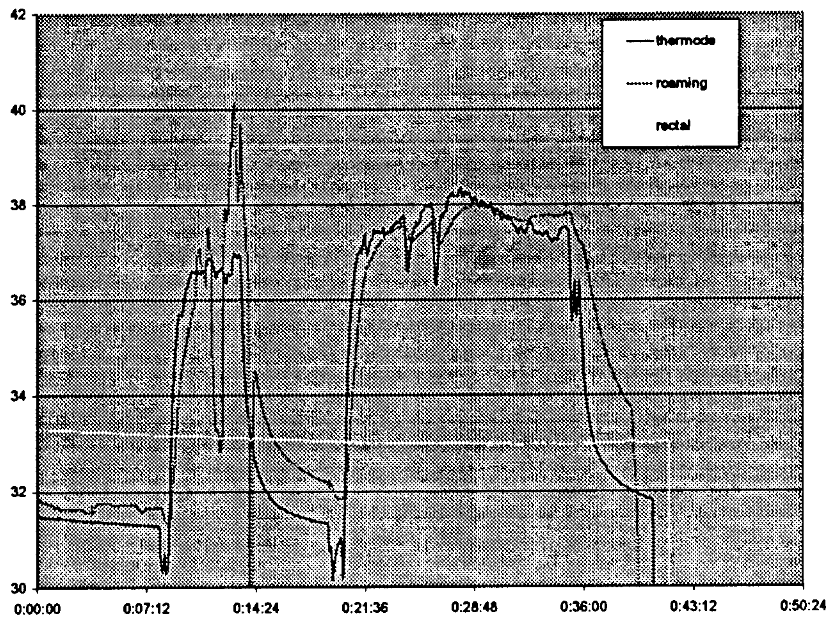
The heating in the brain was fairly localized. The temperatures measured by the roaming probe were a few degrees lower than the thermode each time, though they matched the heating trend of the thermode closely (see graphs). However, there are unnaturally high roaming temperatures attributed to the third rat, number 47.04. A mishap occurred during experimentation on rat 47.04, in which the tubing near the rat's head became disconnected and leaked hot water directly onto the rat's exposed cranial cavity. The water came into contact with the probes briefly before it could be mopped up with gauze, elevating the temperature readings. The roaming probe was inserted less deeply than the hypothalamic probe and therefore was affected more so by the spill than the thermode. Rectal probes inserted into two of the four rats showed that the body temperatures of those rats remained at normal levels, from 33°C to 38°C.



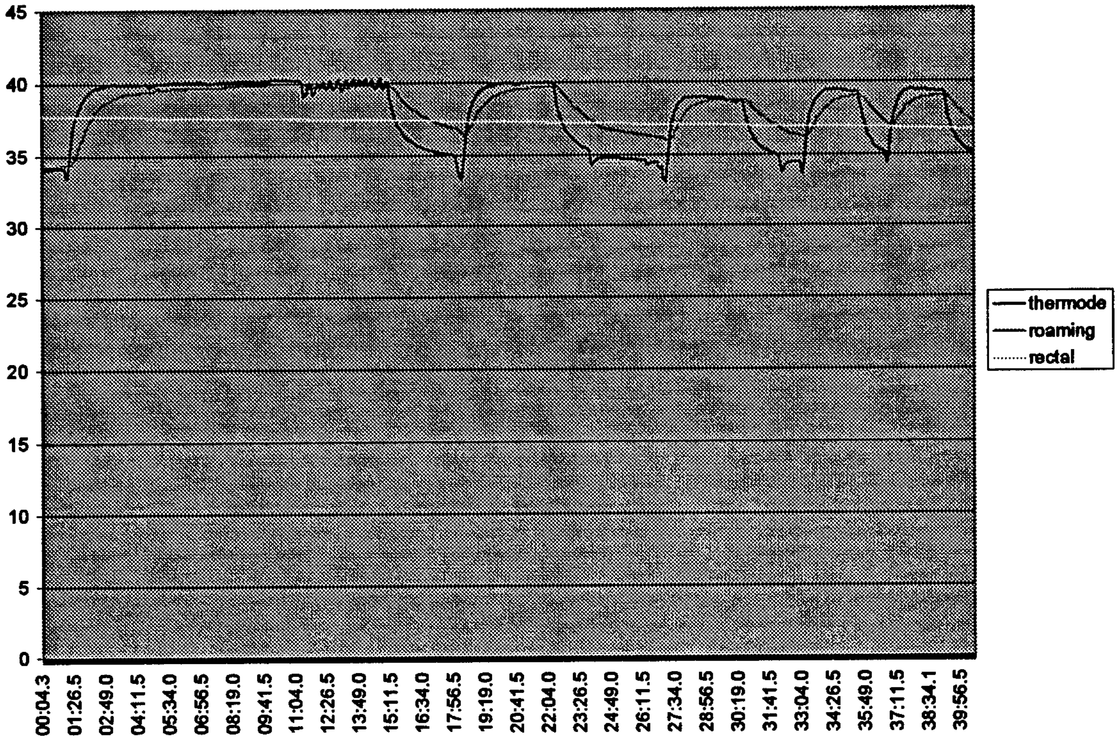
Rat #: 51.16
Date: 7-16-98



Rat #: 47.00*
Date: 7-16-98



Rat #: 47.04
Date: 7-22-98



Rat #47.05
Date: 7-23-98

*Due to incomplete data collection, the rat number and date of the second rat operated on were not recorded. The number 47.00 was arbitrarily assigned to the rat because it was known to have been a part of the 47 series.

Conclusion

The study was successful in devising a method to heat the brain and the body of a rat separately. The probe can heat the hypothalamus to temperatures in the vicinity of 42°C without affecting the rat's core temperature. In the actual experiment, the rat will be able to run on the treadmill while the thermode effectively measures his hypothalamic temperature and a rectal probe measures his core temperature. By using this method, the amount of heating occurring in the rat's hypothalamus can be controlled by the experimenter, and the temperature of the hypothalamus can be experimentally regulated at a steady level. Since there exists a significant difference between body and brain temperatures, the effects of hypothalamic temperature can be singled out. The problem of the two temperatures equilibrating is also eliminated, for the brain is kept heated continually, instead of being heated once for a given amount of time by microwave exposure. Core temperature will not rise to meet brain temperature because the rat's body is not heated along with its brain. If indeed brain temperature is the cause of exhaustion in rats, a rat will exhibit signs of fatigue, though his body temperature remains low.

1. Walters, TJ, KL Ryan, LM Tate, and PA Mason. The influence of the brain and core temperature on endurance performance. FASEB J 12: A54, 1998.

REPORT ON THE PUBLICATION OF RESEARCH PAPERS ON THE INTERNET USING HOT DOG PROFESSIONAL 5 AND MICROSOFT FRONT PAGE 98

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Final Report for:
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Air Force Office of Scientific Research
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August 1998

REPORT ON THE PUBLICATION OF RESEARCH PAPERS ON THE INTERNET USING HOT DOG PROFESSIONAL 5 AND MICROSFT FRONT PAGE 98

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Abstract

With the expanding uses of the Internet, scientists are interested in creating databases in which their work can be published that are accessible through computers. The task given was to create web pages out of bound publications using hypertext markup language (html). Two different programs, Hot Dog Professional 5 and Microsoft Front Page 98 were used for comparison against each other, with the two primary web browsers targeted being Netscape Navigator 4.04 and Microsoft Internet Explorer 2.0. In using the two programs, differences in ease of use, options available, and customization became apparent since Hot Dog seemed more oriented towards experienced page designers and Front Page towards beginners in html. It was important also to test pages on different browsers because of differing interpretations of html which allow certain program commands to be effective on some browsers and ignored on others. Netscape and Explorer were chosen because of their wide usage and popularity.

REPORT ON THE PUBLICATION OF RESEARCH PAPERS ON THE INTERNET USING HOT DOG PROFESSIONAL 5 AND MICROSFT FRONT PAGE 98

Lauren M. Lamm

Introduction

The burgeoning Internet is a tool whose list of uses is growing just as quickly. One use that is of interest to the scientific and academic communities is the creation of databases that provide easy access to information and studies from anywhere at any time, as well as providing a place for scientists to effectively disperse findings from their work. A web page that presents a scientific report would be the ideal way to organize and distribute research quickly and without the cost, time and limitations of a bulky paper publication.

Methodology

To build a standard web page requires the use of hypertext markup language (html), a set of program commands, or tags, that tells a browser how to display the text within which it is dispersed. For instance the command "..." tells a browser to present the text between the two bracketed commands in boldface, where the first direction activates the bold font and the second one with a slash before it deactivates the boldface. This practice of activating and deactivating orders is the most basic core of html. Also, true to its name is the markup aspect of html. Markup is the addition of details to a tag that tell a browser specifically how to handle a command, as in the case of setting up paragraphs. The basic command for the formation of a paragraph, <p>, may have details given to it, telling it to align along the left or right margin or center itself in the middle of a screen. The result would be either <p align="left">, <p align="right"> or <p align="center">, respectively. In this way, fonts can be chosen and given a certain size, tables can position their data in precise locations within cells and upon a screen, links can take the user to other specified locations and so forth.

Special computer programs can be used to help add html to a piece of text and place it officially on the Internet. In this case two different programs were used for comparison with one another: Hot Dog Professional 5 and Microsoft Front Page 98.

Essential to an effective Web page, also, is the previewing of the text, complete with html, on multiple browsers to verify an accurate layout of the presented information. The reason for this is the use of different browsers on the Internet, none of which may interpret an html command in the same way as another. An example is that although Netscape Navigator reads and displays superscript and subscript commands accordingly, Internet Explorer does not accept such commands and simply ignores any of the kind. Thus, it is necessary to test a page and use trial and error in order to find a set of commands that browsers can agree upon and still accomplish the intended display. Most page-building programs offer preview features of a document for this purpose. On this particular project, the two browsers selected for testing were Netscape Navigator 4.04 and Microsoft Internet Explorer 2.0 for the reasons of popularity among Internet users and for their primary use by U.S. military installations, where most of the research concerned is produced and read.

Results

The use of Hot Dog and Front Page programs in page building led to two very different end products, although both results were equally presentable and suitable for the Web.

Customization options were more available on all levels of Hot Dog, as opposed to Front Page. While Front Page automatically adds deactivation commands that aren't necessary in order to keep the page as desired, Hot Dog does not, allowing a document to take up significantly less memory and thus be speedier in downloading for users. Layout customization of the html source is also achievable with the latter program. An example is Hot Dog's ability to let the author place table information in long rows, instead of automatically placing each new table cell tag on a new line as does Front Page, thus making the time necessary to scroll through a document much shorter. Hot Dog has toolbar buttons that specify commands that are intended for beginners in html writing and can be removed for the more experienced page designer. Marker options let the designer jump to specific places within a file document, or sections of text can be collapsed to make scrolling through a file quicker. This program allows for the document as it is to be presented on the Web to be seen on the same screen with the html text in a split-screen mode. It also allows multiple documents to be opened at once so that it is easier to move among them when creating pages that are interlinked. Overall, when compared with Front Page, Hot Dog seems easier to customize, and it appears to be a tool for the more experienced html writer.

Front Page, however, offers its own advantages, especially for novices. One Web view attribute lets the programmer directly manipulate the text to be shown as wished on the Internet, so that knowledge of html is not necessary. Front Page comes with pre-formatted pages with elaborate designs so that all that is needed is the text to be supplied by the page author. Finally, a storyboard feature allows a designer to set up and link multiple pages by mapping connections between icons that represent the pages.

Some minor difficulty was encountered in testing the pages in the browsers. On some points, Netscape and Internet Explorer disagreed, as on the aforesaid problem with Explorer's inability to recognize superscript and subscript. Netscape, also, had its own indifference to markup on anchor tags (commands which create links) that were not in quotations, even though Explorer could work without quotations.

Conclusion

Given the materials to create Web pages, the problems are very minor, and it is quite easy for anyone to establish a database for scientific research. The practice of creating a publication base in this way would be extremely beneficial to those in the scientific community, where the time and cost of creating and shipping bound books and pamphlets is precluded, and the knowledge is not limited to the places where such publications are found.

ANALYSIS OF ERROR FREQUENCIES OF AN ON-LINE PE-INPUT HANDWRITING RECOGNITION SYSTEM

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Sponsored by:
Air Force Office of Scientific Research
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August 1998

ANALYSIS OF ERROR FREQUENCIES OF AN ON-LINE PEN-INPUT HANDWRITING RECOGNITION SYSTEM

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Abstract

The performance of an on-line pen-input handwriting recognition system, Communication Intelligence Corporation's Handwriter ® Recognition System, was studied. Input data was developed to test character recognition errors, case errors, word recognition errors, and editing capabilities of the system. Subjects were recruited to enter the data into the computer. The data was then stored, and the errors were calculated. As expected, the error rates for individual characters varied, as did the error rates between subjects. The overall character recognition error frequency rate for individual characters was 6%. The overall word recognition error frequency, including all errors, was 19%. The average error correction time was 11.6 seconds per mistake. The results indicated that both the recognition performance and the editing capabilities of the software were less than desired for use in a current logistics application.

Analysis of Error Frequencies of an On-Line Pen-Input Handwriting Recognition System

Christina R. Maimone

Introduction

Integrated Technical Information for the Air Logistics Center (ITI-ALC) is a program that has been undertaken by the Air Force through the Air Force Research Laboratory's Logistics Readiness Branch of the Crew Survivability and Logistics Division (AFRL/HESR) to integrate information from a variety of sources into a single source for use in support related maintenance operations. This program has developed into a portable web-based system which requires input from the user. Among the input devices under investigation and in current testing is a pen input device. A pen is used for both a pointing device equivalent to a mouse as well as a writing instrument. When used as a writing instrument, written input is translated or converted into typeset by a handwriting recognition software program. The technology of computer handwriting recognition from pen input is a developing field with improvements being made constantly. Despite promising improvements for the future, however, the current technology available that is compatible with the ITI-ALC system is not as accurate as desired. The handwriting recognition software in current use in the ITI-ALC program, CIC's Handwriter ® Recognition System, fails to correctly recognize a large percent of characters, and thus words.

Pen computing and handwriting recognition are not new concepts. Their origins date back over 40 years when they began as only ideas and visions of portable systems capable of interaction with humans. Systems were developed over the years, but none were perfected enough for wide use. The first practical pen based system to be widely used was Apple's Newton in the late 1980's [1]. Since then, dramatic improvements have been made in both small personal computing systems and pen-input devices. New research and technology developments are seeing handwriting recognition systems approaching the performance level of humans. Human identification of printed uppercase letters viewed singularly has been reported at 96.8% [2]. Some current handwriting recognition systems boast character recognition rates upwards of 93%. While there is still a gap to close, the technology is improving. In achieving a recognition rate that would match humans, developers would also meet the recognition rate deemed acceptable by users for personal notes and informal communications, set at approximately 97% [3].

There are two types of handwriting recognition, each of which presents its own challenges for reaching a high recognition rate. Off-line recognition deals with recognizing handwriting after it has been written, in a system which reads addresses on envelopes for example. Off-line recognition, using only static information, does not have the benefit of data on how the letters were formed, only what their end form is. On-line recognition recognizes handwriting as it is being written. Handwriting is usually entered with a special pen or stylus onto a digitizer, or special computer screen. Dynamic vector data on the movement of the pen is utilized to aid in recognition of characters. This study deals exclusively with on-line recognition. The primary difference between on- and off-line systems is that on-line systems recognize and use data from the formation of letters. On-line recognition systems use the way a character is formed to help identify it. Users who form letters in unorthodox ways would generally experience more errors in a recognition of their writing by an on-line system than an off-line system because of the use of this data. Most users, however, are able to achieve higher recognition rates with an on-line system because of the added dynamic information. Two main issues remain that must be dealt with by both types of recognition to improve rates. These are case identicals, letters which have the same form in both lower and upper case, and characters with similar forms such as '2' and 'Z'. The general trend for dealing with these problems is the use of contextual clues and dictionaries to make best guesses of the input in question.

While the usability of pen input systems is not entirely dependent on handwriting recognition accuracy, "The accuracy of handwriting recognition is often seen as a key factor in determining the acceptability of hand-held computers that employ a pen for user interaction" [4]. An earlier trial of the ITI-ALC system showed that much of the frustration users experienced with the system was as a result of handwriting recognition errors. Since the handwriting recognition proved to be a significant issue in the usability of the system, it was decided to evaluate the performance of the handwriting recognition software. This study focused entirely on handwriting recognition rates to gather data to supplement other overall usability studies of the ITI-ALC system.

This study was undertaken to investigate the current error frequency rate of the handwriting recognition software and to produce information as to the common errors and difficulties of the software. Both observational and quantitative data were collected to aid in this objective.

Experimental Development and Methodology

In order to evaluate the Handwriter ® Recognition System, it was determined that subjects would be asked to copy predetermined data into the computer, a Fujitsu ® Stylistic 1200, after a short practice period data would be entered and stored so that the errors could later be counted. The first step in developing this study was to form the practice/training session and the input data.

The training session was developed by combining tips and training provided by the Handwriter ® system and experience of previous users. A page of user tips, do's and don'ts, and instructions on system use was developed. The first operation the subjects performed in the training session was to answer the questions on character formation in the trainer provided with the software. The purpose of this trainer is to train the Handwriter ® system, not the user. The rest of the training session included ideas on achieving better results, instructions for using the editing tools, and suggestions for activities to be undertaken in the free-writing time allowance. The training page was developed with the intention of guiding subject through the page with demonstrations, and then they would be allowed to become familiar with the system and use the different tools for a period up to ten minutes. The training sheet is included in Appendix A.

The input data was developed with several purposes in mind. First, all of the characters needed to be tested, so it was determined that each character must appear at least twice, with higher frequencies for most letters. All characters were to appear twice to avoid a 100% or 0% recognition rate based on one instance of the character. Second, case needed to be tested, so uppercase letters must appear both in all capital situations and in combination with lowercase letters. Third, usability of editing features needed to be tested, so the subjects were made to edit a selection. Lastly, the data needed to be entered in several different situations, including copying unfamiliar sentences, writing from memory, entering data into small boxes, and copying a selection similar to ITI-ALC input.

Thus, the input data was set up in three main parts. Part 1 was developed to test character recognition and case errors. It included copying unusual sentences in different cases, and it also called for the subjects to write the Pledge of Allegiance from memory. Part two involved inputting data similar to ITI-ALC input. Part 2 was a further extension of character recognition and case error testing, as well as serving as an editing test. Subjects had to edit a copy of the inputted paragraph and were timed. Part 3 involved entering uppercase letters and numbers in mixed combinations into small boxes. Preliminary testing was done with all of the input data before it was used in the experiment. Data such as character and word frequencies was then collected on the input for use in error calculation. The input data is included in Appendix B.

The next development step was to write a questionnaire to gather subject's reflections on the system after use. The questionnaire was not developed to obtain specific information for a particular purpose, but rather to obtain a general idea of the subject's opinions and insights into the system and their own writing. It was given to the subjects after the completion of the entire test. The questionnaire is included in Appendix C.

Once the test was developed, the subjects were selected and the testing began. The subjects were chosen on a volunteer basis. The only restriction was that the subjects should have little to no experience with the system. Nine subjects volunteered, but, due to computer malfunctions, the data for two subjects was lost, resulting in seven sets of data in the end. The number of subjects was determined by time constraints and the need for a reasonable amount of data. Both male and female subjects were used. All of the subjects were right-handed by chance. The input data in parts one and two was entered in the writing palette, without the box guides, that comes with the Handwriter ® system. The data was then copied into Word Pad, an accessory program of Windows 95, and saved for later analysis. The input data for part three was entered into a pre-existing program called STEP which is used for another logistics program. It was chosen because it contained small text boxes into which the data could be entered. Analysis of the data for part three was done immediately after entry while the subjects filled out the questionnaire.

Errors were then counted and entered into a spreadsheet for analysis. The errors were counted based on criteria determined before the test. Character recognition errors were determined as the incorrect recognition of an inputted character as another character or characters, with case errors not counting as recognition errors. Thus, an 'A' recognized as an 'a' was not counted as an error, while an 'A' recognized as a '4' or 'It' was counted as an error. No recognition of a character inputted was also counted as an error. Punctuation marks were not included in character recognition data, but punctuation errors were calculated in the same manner as character recognition errors. Case errors were determined as the incorrect recognition of a character's case, with recognition errors not being counted. For example, an 'A' recognized as an 'a' was counted as an error, while an 'A' recognized as a 'z' or 'Z' was not an error. This method gives a somewhat skewed view of the case error frequencies because it ignores incorrectly recognized letters (not wrong case) and does not compensate for it in the calculation of error percentages. Nevertheless, the results are considered relevant enough to be taken into consideration. All other errors and calculated methods are explained below.

Results

The results of this test were calculated by the type of error that occurred. Case errors were calculated separately from character recognition errors, punctuation was calculated separately from other calculations, etc. All calculations include data from both parts 1 and 2 combined unless otherwise noted. Several groupings of data were used in calculating results in order to provide different perspectives on the data. There is no general consensus in the field of handwriting recognition on how errors in handwriting recognition applications should be counted, so this data may or may not correspond with that of other studies.

Character Recognition

Based on the above criteria, error frequency calculations for character recognition were calculated by counting the recognition errors for each character, being all numerals and both cases of letters, with each letter being counted by case. The number of errors per character for each subject were counted. These numbers were then averaged for each character. The averages were then used to calculate the error percentages. Error percentage is calculated as the average number of errors divided by the total number of that particular character that were to be entered. Error frequencies were determined for lowercase, uppercase, total letters, numbers, and for each letter without regard to case.

For lowercase letters, the error frequencies ranged from 0% to 11%. For uppercase, the range was 0% to 46%, with the second highest percentage being 19%. For numbers, the range was 0% to 26%, with the second highest being 7%. For letters, regardless of case, the range was 2% to 16%. In general, character recognition depends on how similar a particular character appears to other characters. Those characters which do appear similar to others did have a higher error frequency. The error frequency data for character recognition is shown in figures 1-4.

Figure 1: Lowercase Error Frequencies

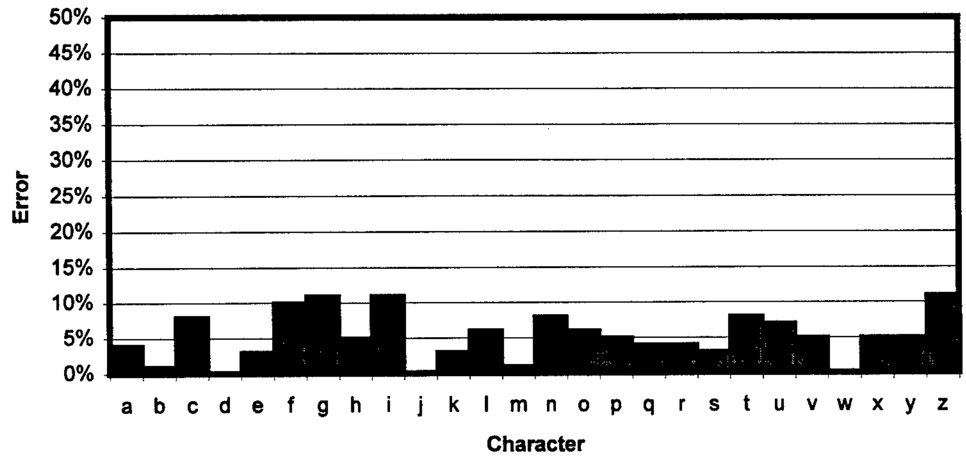


Figure 2: Uppercase Error Frequencies

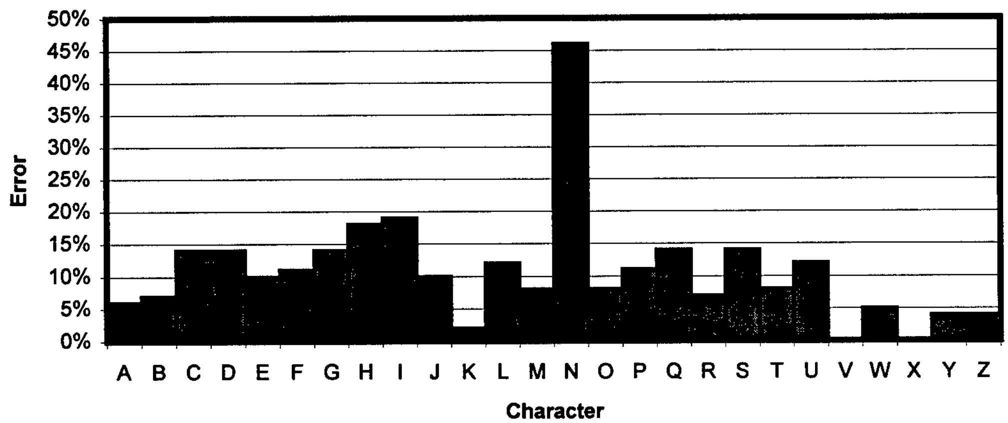


Figure 3: Numeral Error Frequency

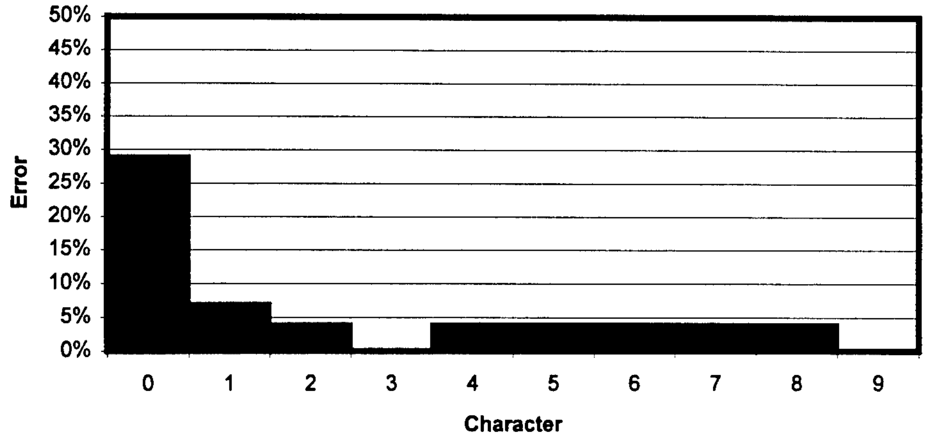
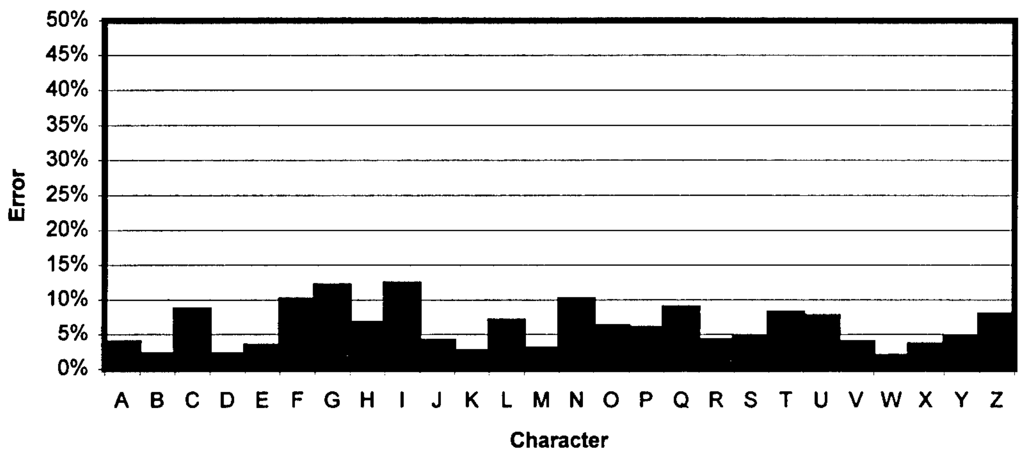


Figure 4: Letter Error Frequencies - Both Cases



All of the characters with high error frequencies either appear as other characters or are written in the same manner as two characters together. The high error frequencies are contributed to by the writing styles of users who do not form these characters distinctly from others. Standard deviations were also calculated for each of the characters. Approximately half of the characters with high error frequencies have high standard deviations, suggesting that writing style is a major factor in recognition. High standard deviations show that for some characters, the error frequency may be due to a few subjects whose formation of a certain letter was not understood by the recognition software as opposed to a uniform error frequency overall. This is supported by comparing the letters which had the highest error frequencies for each subject. This was done by tabulating the top 3-5 letters per case for each subject that had the highest error frequencies. The variation in number between subjects was necessary because of expansive ties in rankings for letters beyond the top 3-5. Figure 5 shows the letters along with the number of subjects who had that letter in the top 3-5 letters. The fact that no letter appeared in the top few for a majority of the subjects indicates that the Handwriter ® Recognition system may not have overwhelming trouble with a few characters, but rather it may have trouble with a wider range of variations on letters that are largely user dependent.

Lowercase Top Errors			Uppercase Top Errors	
Letter	# of Subjects		Letter	# of Subjects
g	3		B	3
f	2		D	3
i	2		G	3
n	2		H	3
t	2		I	3
u	2		N	3
c	1		F	2
h	1		P	2
k	1		Q	2
o	1		S	2
p	1		U	2
q	1		C	1
v	1		E	1
x	1		J	1
y	1		M	1
z	1		T	1
			Y	1

Figure 5 - Top Error Frequency Distribution

Overall, looking at the error frequencies of characters, uppercase letters are twice as likely to be misrecognized than lowercase letters or numbers. The reason for this may be that many uppercase letters are formed with multiple pen strokes that can result in a letter being recognized as two. It may also be a result of the lower number of uppercase letters as compared to lowercase. Numbers are likely to have a lower frequency because errors caused by combining letters are eliminated with numbers. The following table shows the error frequencies for each group.

Figure 6: Combined Error Frequencies

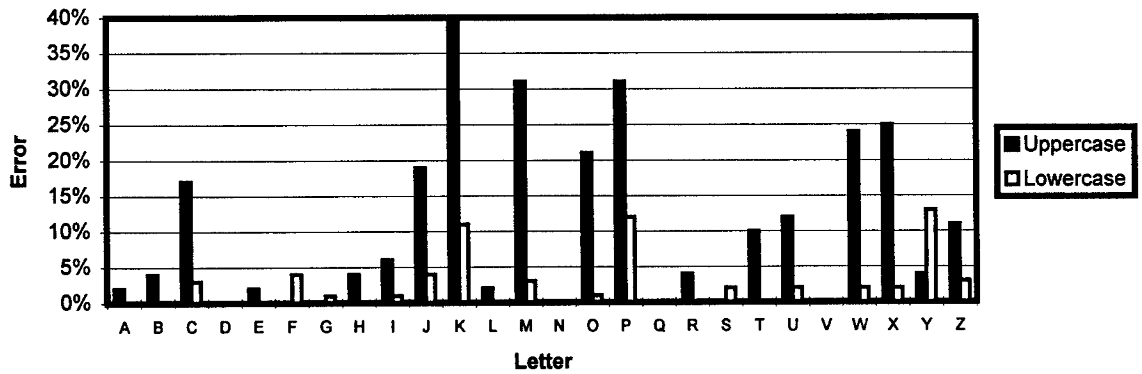
In general, some of the recognition errors can be attributed to inaccurate answers the subjects gave in the Trainer, resulting in the software not being alerted to certain writing styles, or unusual formation of letters. Errors of this type are to be expected in any online recognition system that recognizes characters based on the way in which they are formed and not the end appearance. It is impossible to tell from this experiment what part of the total errors these user errors constitute.

Case Recognition Errors

Case recognition errors were counted as described above for each letter in each case and regardless of case. In addition to testing each letter in both upper and lower case, the input data was designed to test the capitalization of words. Not all letters appeared as capitals at the beginning of a word, but all letters did appear at least twice as part of all-caps sentences. The emphasis placed on case in the input data is most likely more than what would be emphasized in normal use of the system. Case errors, however, do become a more important issue when they are high, resulting in time consuming editing.

One purpose in determining case errors was to observe if the letters which appear the same in both cases indeed had higher case error frequencies. This hypothesis was found to be true. The characters with top error frequencies, both cases combined, were J, K, M, P, W, X, and Y. All of these letters can be written the same in both cases. Along with these letters, the letters C, O, and Z also had high case error rates, and all can be written the same in both cases. The following graph shows the case error information for both cases.

Figure 7: Case Errors



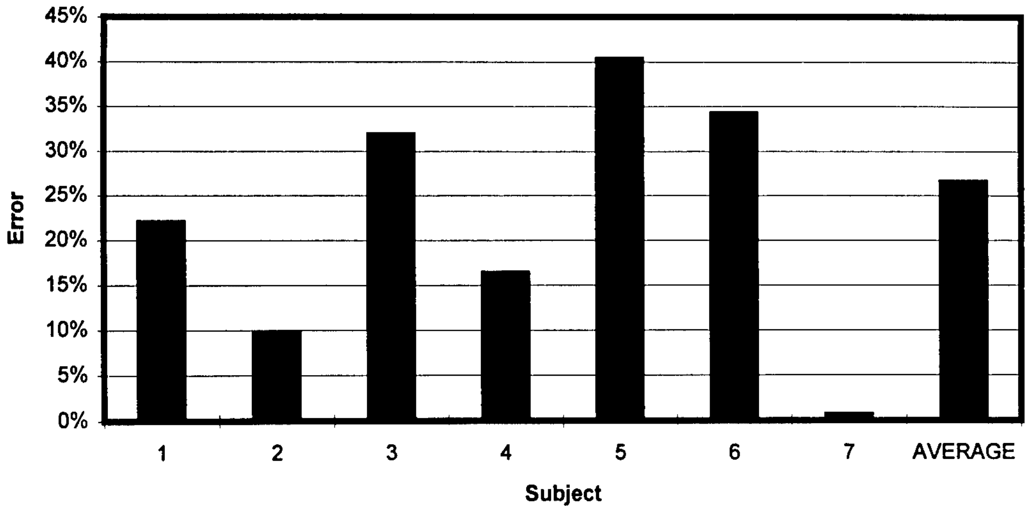
Punctuation

Punctuation recognition was tested only minimally. Each punctuation mark was to be entered at least twice during the test as part of the other input data. The marks were to be written rather than entered using the keyboard or editing palette. The error rate was lower for periods and commas, at around 20% combined, and higher for colons, semicolons, and other less frequently used marks, at around 40%. Punctuation entry proved to be somewhat frustrating and awkward for the users as observed during testing and taken from the questionnaires. The inability to be able to enter punctuation separate of a word proved to interrupt the flow of text entry.

Word Error Frequency

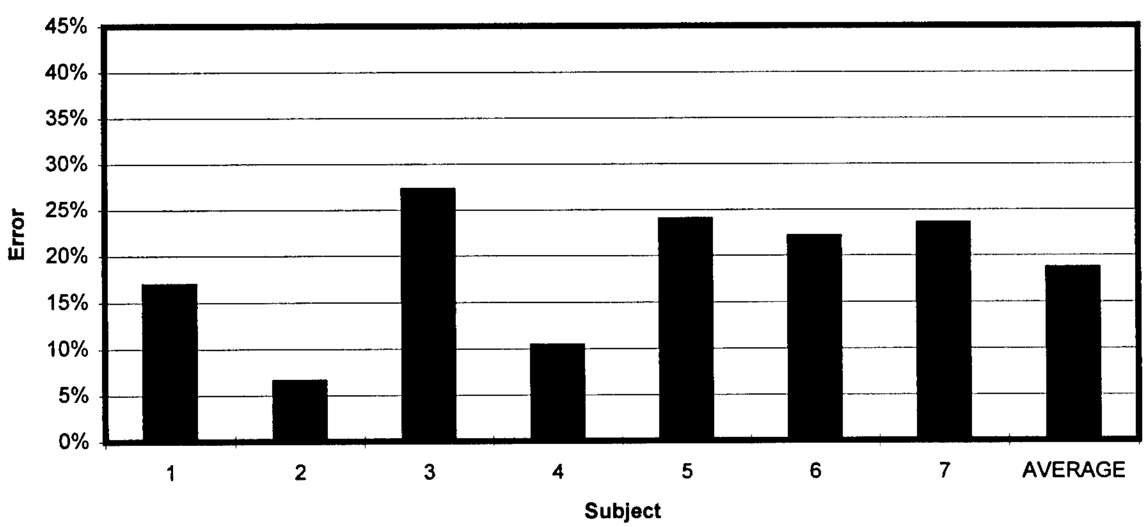
Another way to measure error frequency is to count words as whole entities and to determine the number of words with errors. This can be done in several ways, including different types of errors in the calculations. For this experiment, word error frequency was calculated with two different sets of errors. In both calculations spacing errors between words were not counted although there were a significant number of this type of mistake. The first calculation includes all types of errors, being character recognition, case, extra spaces inside a word, and punctuation that is part of a word (apostrophes, dashes). The results of this calculation are in figure 8. Note the large variance in the error frequency between subjects.

Figure 8: Word Errors - All Errors Included



The word error frequency was also calculated with less types of errors being included. This will obviously lower the error frequency. This calculation included only character recognition errors and errors of punctuation within words. No case or spacing errors were included. Calculated this way, the word error frequencies are as follows in Figure 9. In this calculation, there was less variance between subjects.

Figure 9: Word Recognition Only Errors



Editing

The last area for parts 1 and 2 that was tested was that of correction time. The subjects were instructed to correct a copy of a passage they had previously entered. The errors that needed to be corrected were counted and the correction time of the subjects was taken. The average time per correction was then calculated and determined to be 11.6 seconds. This number alone is somewhat unrevealing. The 11.6 second figure should be taken into context with the average of 47 errors subjects had to correct in a 90 word paragraph. This means that it took an average of over 9 minutes to correct a short 90 word paragraph. The general opinion expressed by the subjects through the questionnaire was that the editing tools and procedures were tedious and inadequate.

Part 3 Results

Part 3 was developed to test the usability of the Handwriter ® system for form-filling applications. Data was collected for part 3 but not analyzed as a result of a change in focus for the study. Results form part 3 were not included in the other error calculations.

General Observations

During this testing process, some general usability observations were made. Along with these observations are the questionnaire answers provided by the subjects. Most of the issues address the usability of the Handwriter ® Recognition System specifically, not the Fujitsu ® Stylistic 1200. There were several concerns with the editing tools, including the absence of arrow keys on the on-screen keyboard, the size of the on-screen keyboard covering too much of the writing area, and the general lack of ease of use of the tools. Also in editing, the ease with which the cursor would move when writing over typewritten text became problematic for the users. Spacing concerns included the inconsistency of the automatic spacing after words and a tendency on the part of many users to hesitate after each word to check spacing and recognition mistakes. The automatic spacing also made it difficult for punctuation to be written if there was any pause after the last word was written. It was difficult for many subjects to alter stylistic habits not consistent with the software such as crossing double t's together and crossing t's and dotting i's after the entire word is written. The rigidity with which the answers to the Trainer questions were applied was also of concern. Any deviation from answered stylistic tendencies was not tolerated by the software. Any subject who did not write 1's with the top and bottom or 0's with a line through them was unable to write a single 1 or 0. Also, for many letters, it is impossible to get a single uppercase version of the letter.

Conclusions

The results of this test indicate that the overall word error frequency and the error frequency of many characters in the CIC Handwriter ® Recognition System is higher than desired for use in the ITI-ALC program. Both error frequencies and usability issues enter into this conclusion. It is possible, however, that with a training program, the system could be made acceptable for the ITI-ALC program's use. Further research would be needed to develop an adequate training program for use of the system.

More specific conclusions about the system can be drawn from the results above. First, the recognition mistakes made by the system are the result of a combination on system flaws and user stylistic habits. This is demonstrated through the types of letters that possess higher error frequencies and the lack of continuity in the lists of top letter errors per subject. Second, case errors are caused largely by letters which have the same form in both cases. Third, the current written, as opposed to keyboard entered, punctuation recognition is poor and awkward. Finally, the editing capabilities of the system are time-consuming, especially for beginning users, and add to, rather than serve to improve, the Handwriter ® system's errors.

Examining the types of errors the system makes reveals that it makes many of the same mistakes humans do in reading handwriting. Most of the errors in character recognition are with letters which look like other characters. The same kinds of recognition errors are also made by humans. One difference with the system, though, is the technology errors, such as spacing, that are made. These errors seem to be a result of insufficient technology being applied to a task. The concept that has been applied is correct, but the ideas did not manifest in the system correctly. More work is required to implement the concepts correctly.

While the CIC Handwriter ® Recognition System in its current form is not easily used by inexperienced people, with practice, time, and training the system could potentially perform at a more adequate level. While a similar study points out that users are not generally willing to adapt their writing style to a recognizer, most users should be able to adapt their writing style to fit with the system's printing only requirements and still maintain a natural flow of writing [4]. Although many subjects were frustrated by certain aspects of the system, most of them could see an application for it in their work or personal lives and could envision themselves using a similar system.

Recommendations

It is recommended as a result of this study that either a new handwriting recognition system be used for ITI-ALC applications, or that a rather extensive training program be developed and implemented for the CIC Handwriter ® Recognition System before users are introduced to ITI-ALC applications. While the need for handwritten input has been largely eliminated in ITI-ALC applications, the information that is handwritten often is the most critical. It is the information that is not standard or predictable and therefore must be very accurate.

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Appendix A

Handwriting Recognition Practice

1. Trainer
2. Keep these things in mind
    - Space words out, don't crowd them together. It will help the recognizer see them as two different words.
    - Try not to crowd letters like c and l very close together. They can get picked up as one letter: cl → d
    - Some numbers look like letters, so make each as distinct as possible.
      Ex. 5 and S, 0 and O, l and 1, 6 and G, 2 and Z
    - Some letters can be written exactly the same in upper and lower case. To have the letter show up in uppercase, it must be written larger than the letters following it, and it must have letters following it.
      Ex. Cc, Jj, Kk, Mm, Oo, Pp, Ss, Uu, Vv, Ww, Xx, Zz
3. Space and delete gestures
    - I will show you, but for reference...
    - The written character or gesture for a space is an upside-down U
    - The delete gesture is used by beginning on the left side of the word, crossing it out, and coming back all in one step.
4. Return
    - The return button is located in the tool bar at the top of the page, as well as in the editor
5. Keyboard
    - The keyboard can be accessed for editing by clicking on the button in the toolbar. Use the pen as a mouse to type.
6. Edit palette
    - The palette contains all of the punctuation marks needed, as well as buttons for space, backspace, and return
7. Highlighting text
    - To highlight text, hold the pen down on the screen, like you would hold a mouse button down to drag something, until it changes to a pointer, and then highlight
8. **NEVER** hit the boxes with a check mark or an X - they will delete all of the data!
9. The gray button
    - The gray button on the mouse is the same as the right button on a mouse. If you hold it down and click, you can access the keyboard, space button, or return key
10. Suggestions for practice - 10 minutes
    - Write all Letters and Numbers
    - Try Punctuation
    - Test spacing of words
    - Practice editing
    - Use the Keyboard

Appendix B

Input Data

General instructions: Please **PRINT** only at all times. Enter all words or letter/number sequences without pausing. Enter all punctuation as part of the preceding word (no pause). You may use the written space character/gesture as you go while entering data if you notice the computer has not automatically advanced the cursor. Please do not, however, go back and edit. There should only be one space placed between sentences. If you make an error entering the data (such as misspelling a word when entering, missing punctuation, extra or stray marks, or pausing in the middle of a word that results in a space in the word) you may correct the error, but please do not correct any errors that the computer, not you, makes.

Part 1 Directions: Please enter all data as shown here, paying special attention to spaces and the case of the letters. Correct only entry mistakes. Enter each line/section of data on a separate line using the return bar in the tool bar.

Section 1:

the quick brown fox jumped over the lazy dogs

the quick brown fox jumped over the lazy dogs

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS

0123456789: 0123456789

Neither Zoo Has Very Many Ugly Queen Orangutans' Xylophones.

A Wonderfully Beautiful, But Lazy, Creature Gave Henry Jr. Killer Masquerading "Experienced" Vultures.

Every Year Thousands Of Scurrying Little Kangaroos Gather Together At The Same Place To Eat Small Unsuspecting Mice From Alabama, Florida, and Kentucky; Why This Exceedingly Grotesque Marvel Happens Is A Puzzle.

Section 2: Write the pledge of allegiance, with capitalization (I, United, States, America, God) but no punctuation, and make only entry corrections.

Part 2 Directions: Please write the next paragraph completely, making only entry corrections. STOP, and let me know at this point. You will then select the paragraph and copy it below the original. You will be correcting the paragraph completely, and I will be timing the corrections. There is only one space between sentences. Let me know when you are finished.

There's a crack in the left wing. It is approximately 14 inches long. I have brought it to the attention of the head mechanic. To replace the wing, the part number is CLM13579; Compatible part numbers are: V24680PZWO and YNKLQ765890. I cannot just use what I have here. I have also discovered a problem with the engine. It is unusual in structure and may have been fixed by an "inexperienced" mechanic. While these problems exist, the ZX-23 is still in working condition and is available to run emergency battle operations.

Part 3 Directions: Part 3 requires switching to another program. You will be entering data into small boxes. Please make no corrections. Follow the directions as to where each code should be entered.

In the Box marked "Facility Number" enter: KJDCL28ZUG
In the box marked "DSN Phone" enter: BFNQMW67
In the box marked "# of Offices" enter: 13579
In the box marked "# of Restrooms" enter: 24680

Click on the page for doors at the bottom of the page

In the box marked "Type of Hasp/Lock" enter: RESTAIVOXYPH
In the box marked "# of doors" enter: 12345
In the box marked "opening height" enter: 67890543190
In the box marked "opening width" enter: 2169708345

Thanks!!!!

Appendix C

Questionnaire

Subject # ______

How much did you have to alter your handwriting to get the computer to recognize it?

How do you rate your handwriting?

Great 1 2 3 4 5 Illegible

Do you have any unusual elements to your writing (like writing a certain letter in an unorthodox way)? If yes, what?

Do you normally print? Yes No

Describe your experience trying to edit (particular problems, usability of the editing palette, etc.):

Would you use this system for any task you now perform on either a computer or handwrite on paper? If yes, what? If no, why not?

Have you had any previous experience with the system? If yes, did the system do a better job of recognizing your writing this time/did you learn what the system was looking for?

SOFTWARE ANALYSIS OF EEG WAVEFORMS AND REAL-TIME MEASUREMENT OF SUBJECT CONSCIOUSNESS

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Final Report for:
High School Apprenticeship Program
AFRL/Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Armstrong Laboratory

August 1998

SOFTWARE ANALYSIS OF EEG WAVEFORMS
AND REAL-TIME MEASUREMENT OF SUBJECT CONSCIOUSNESS

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Abstract

Research into the effects of high G-forces on rat EEG's led to the discovery of a connection between the power of EEG waves near 40Hz and the level of subject consciousness. This indicator, along with other frequencies present in the brain, was used as the basis for a real-time software consciousness metric. The software was designed using LabVIEW instrument engineering technology. The level of abstraction that is provided by the LabVIEW environment allows the EEG analysis software to be interfaced with a variety of data acquisition boards and vital signs monitors.

SOFTWARE ANALYSIS OF EEG WAVEFORMS AND REAL-TIME MEASUREMENT OF SUBJECT CONSCIOUSNESS

Edwin McKenzie III

Introduction

Measuring subject consciousness in real-time using EEG waveforms is a problem that has been considered for some time. Until recently, however, two problems precluded the development of such an instrument. First, the computer processing power necessary to accomplish EEG analysis in real-time was only available in high-end computer systems. Second, the traditional breakdown of EEG frequencies into bands did not take the 40Hz frequency, the prime indicator of subject consciousness, into consideration. These problems have been overcome; rapidly increasing CPU speeds and the findings of high-G rat research have made software analysis of EEG waveforms feasible. The software engineered in conjunction with the Air Force Research Laboratory is in its preliminary stages, although once completed it could be used in mission-critical situations. For example, gravity-induced loss of consciousness (GLOC) is a problem for pilots of high-performance aircraft. Having EEG analysis equipment and the necessary software, a more sophisticated system could predict and initiate an automated response to the pilot's changing conditions.

Methodology

The process of developing a digital indicator of subject consciousness (DISC) involved three stages. First, large amounts of vital signs data were collected on rats subjected to high-G forces by means of centrifugation. This led to more detailed analysis of the EEG data, which revealed a number of clear relationships between subject consciousness and the observed behavior of each band in the EEG spectrum. A mathematical algorithm was devised for computing a scalar consciousness index from the analysis of the EEG across the spectrum, and the final development stage involved translating this algorithm into software. The DISC was developed using LabVIEW engineering software, which simplified the task of acquiring data from the proprietary data acquisition board as well as generating real-time charts and graphs of the collected data. Use of the LabVIEW programming language also ensured portability between PC, Macintosh and Sun machines, an important consideration in the scientific community. After the DISC prototype was a workable model, it was tested extensively on rats under acceleration stress in the centrifuge as well as human subjects in controlled environments.

Results

The software DISC in its current form is a fairly reliable metric. In all trial runs involving rats exposed to high-acceleration G-forces, the software correctly indicated loss of consciousness as well as subject recovery. In the instances were a rat did not recover, the DISC registered negligible consciousness, as expected. Thus, for rats under z-axis acceleration, the indicator has proven to be quite accurate. However, in tests on humans, results were mixed. Muscle strain did not affect the DISC reading, which is an improvement over other consciousness metrics; however, rapid blinking causes a false indication of unconsciousness. The reasons for this phenomenon are not yet known, although it is suspected that a shift in EEG frequencies down into the lower range may be the underlying cause. A major problem in testing the DISC on human subjects is the reliability of the electrodes used to monitor EEG waveforms. While probes were surgically implanted on rat subjects, for obvious reasons intrusive electrodes could not be used on humans, and as a result the DISC was subjected to noise from various sources.

Conclusion

The DISC is a fully functional model that works under most circumstances. It correctly signals loss of consciousness, as well as clinical death. However, as testing on humans revealed, the algorithm for computing subject consciousness is far from complete. More research on rats as well as human subjects will be needed in order to make the DISC a more reliable indicator of subject consciousness.

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

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Final Report for:
High School Apprentice Program
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Air Force Research Laboratory
Brooks Air Force Base, TX

August 1998

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

Michael G. Anderson and Charles H. Mims
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Abstract

Induced transmittance of laser eye protection served as the research focal point. Twelve samples of Laser Eye Protection (LEP) underwent tests to detect induced transmittance. The laser configuration delivered ultrashort pulses at 800nm to the samples. Energy generally varied from 5.0E-8 to 6.0E-5 Joules and pulses were typically in the 90 - 130 femtosecond range. The experimental results revealed that no samples exhibited induced transmittance with satisfactory certainty. Some examples did show a decreasing pattern of optical density, but the variation in optical density was insignificant.

STUDY OF INDUCED TRANSMITTANCE IN LASER EYE PROTECTION AT ULTRASHORT PULSES

Michael G. Anderson and Charles H. Mims

I. Introduction

Recent revolutionary developments in LASER (Light Amplification by Stimulated Emission of Radiation) technology have prompted the need for research and development of laser eye protection (LEP). High intensity laser beams can cause visible lesions and even hemorrhages on the retina of the eye. As a result of the increased use of lasers in the battlefield, the military sponsored research to improve laser eye protection. Current laser eye protection can significantly reduce the transmittance of selective wavelengths of light. However, after testing LEPs at the femtosecond (10^{-15}) range, a phenomenon known as induced transmittance or "bleaching" was discovered. Bleaching occurs at ultrashort pulses when the absorptive material in the LEP cannot absorb the laser beam fast enough to prevent transmittance. Bleaching has become a major issue in the field of laser research. Many manufacturers of laser eye protection have stopped production of LEPs based on the discovery of bleaching effects at the ultrashort range. The halt on production was ill advised because laser eye protection is still effective against laser radiation at the non – ultrashort range. Our research concentrated on LEP bleaching at the 800nm wavelength. The experimentation continued the research of several pioneers of this field at the Air Force Research Laboratory, Armstrong Research sight.

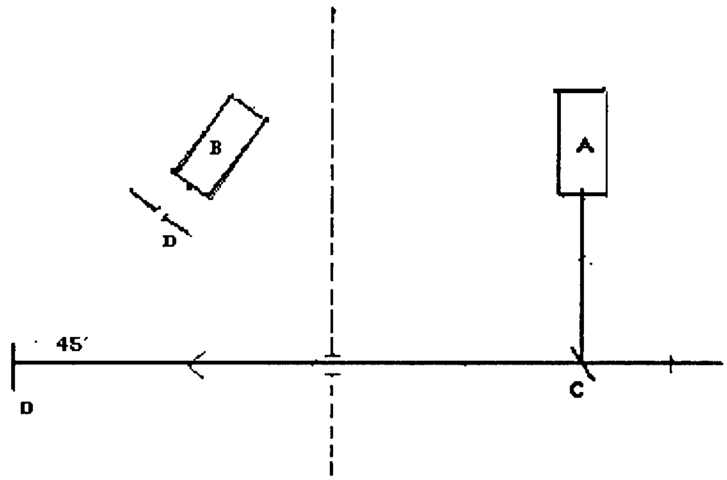
Experimental Procedure

The first step of the experiment involved intense research into laser technology. We were briefed on laser safety and how to correctly operate the lasers. The first days in the lab involved familiarization with the lab equipment.

The next part involved the construction of a "light proof" optical enclosure. This enclosure was created to block out stray light from the detectors. Corrugated black plastic board served as the walls of the enclosure. The dimensions were 16" wide, 24" long, and 10" high. This completely surrounded the optical breadboard with a 4" width overhang for more detector space. Black felt lined the inside of the box to help ensure the least amount of possible light entrance. After the construction of the optical enclosure, the samples of laser eye protection were catalogued. Optical elements were aligned on the optical table to direct the beam into the optical enclosure. The setup was then aligned with a Helium Neon laser.

Data collection began with the calibration of the two detectors. The calibration of the detectors without a filter in the beam path of either detector presented an accuracy problem. Prior to our experiment, Ben Rockwell already solved this problem with the patented setup described below.

II. Calibration Setup



A: Detector J3-09 #451 (calibration date 2-28-98)

B: Detector J3S-10 #0538D98

C: Beam Splitter (80% transmission, 20% reflection) UT-800-20-45-UNP

D: Diffusion Plate (k = 0.514) labsphere REP#8433-1-2

E: Aperature, r = 1.2mm

D->E: 156mm

E->B: 58mm

* the dotted line represents a separation board within the setup enclosure

** an 800nm filter was fixed to the front of the J3S throughout the experiment

To calibrate the J3S detector, we used a technique for creating a known optical density that is described by the equation

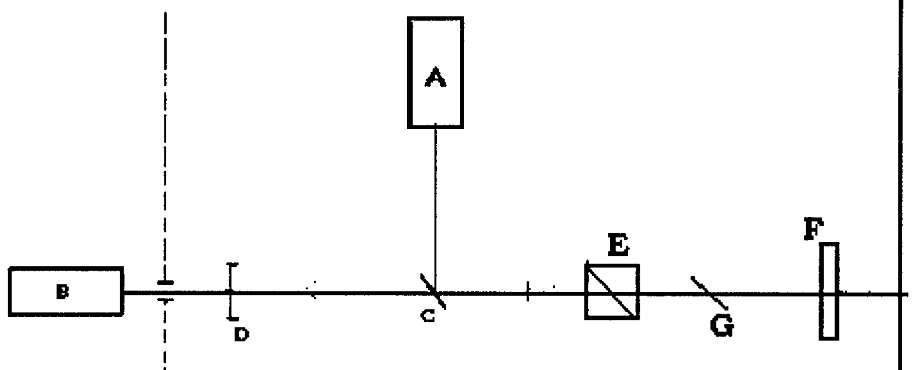
$$OD = -LOG10((K * s * \cos \Theta) / \pi R^2)$$

Our setup included a diffusion plate with the reflective constant K = 5.14, an aperture area, s = 1.2mm², an angle, $\theta = 45°$ and a distance from diffusion plate to aperture, R = 156mm. The ideal OD according to this model is then 4.67.

Initially, our energy results did not conform to this model. We determined that because the polarization of the beam was not consistent as the pulse energy was varied, the beam splitter within our experiment did not have reliable beam splitter ratios for each pulse. A polarization cube placed in the beam path before the beam splitter corrected this problem. Ultimately, the ratio was determined to be a factor of 2.3 so that with data from detectors A (J3) and B (J3S) the optical density could be determined as

OD = -LOG10(B/(A*2.3))

III. Experimental Setup



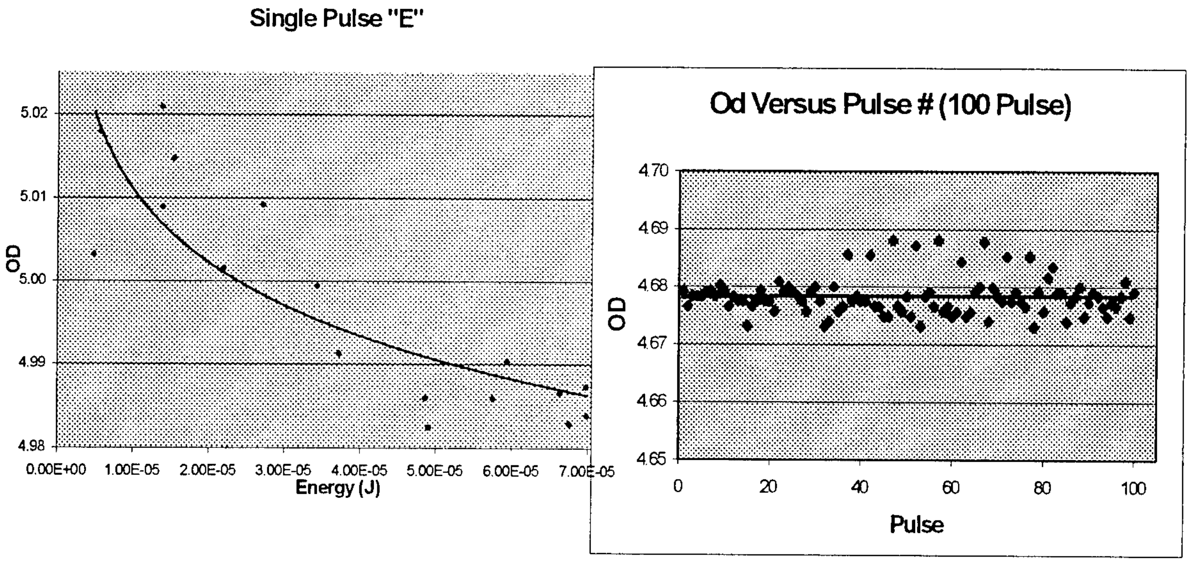
A: Detector J3-09 #451 (calibration date 2-28-98)
B: Detector J3S-10 #0538D98
C: Beam Splitter (80% transmission, 20% reflection) UT-800-20-45-UNP
D: LEP
E: polarization cube
F: 1/2 wave plate
G: polarized beam splitter

* the dotted line represents a separation board within the setup enclosure
** an 800nm filter was fixed to the front of the J3S throughout the experiment

After calibrating the detectors, we determined the standard optical density for the setup (this step was done daily). Then we determined a method of securing the LEP samples in a constant position that was normal to the beam. The LEPs were held in place with a three-prong test tube clamp. Hole-punch reinforcement-style stickers were placed on the LEP. First, they insured that the same point on the LEP was hit with each set of pulses. Secondly, they marked the point of impact for microscopic inspection. The illustration above shows our setup.

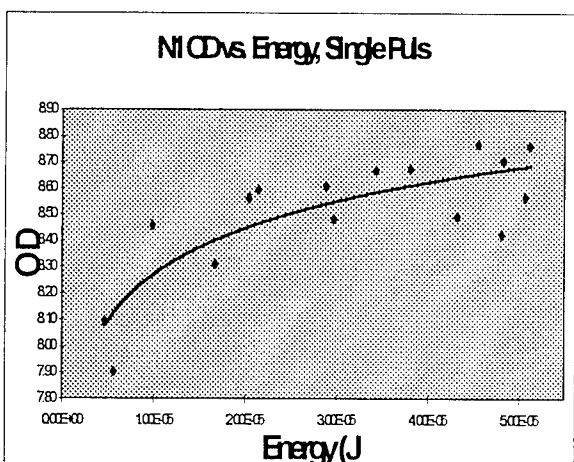
The laser beam energy was controlled using a half wave plate and polarized beam splitter attenuator. Also, a polarizing cube was placed in the beam path to reduce the effect that varying energy had on the beam splitter within the setup. Preliminary calibration showed that the cube increased our data reliability by a significant figure.

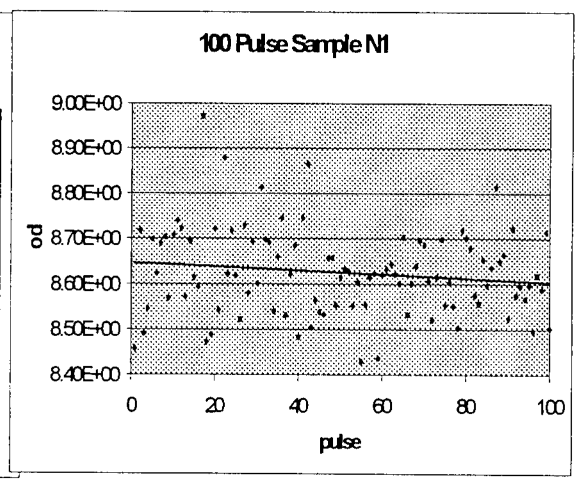
Data was recorded for all samples in sets of single pulses and 100 pulses with a 5° rotation of the wave plate between each shot (240° - 205°). For the multiple pulse readings, we used LabVIEW for Windows to record the data. Gary Noojin programmed a Virtual Instrument with this software. Through computer interface with data acquisition boards, the time required to collect the data was drastically reduced.



IV. Data Analysis

Sample "E" above exhibited unexpected results. At single pulses, the sample showed a slight bleaching trend. However, at 100 pulses, the optical density versus pulse number increased slightly. The results are probably accurate, but any miscalculation could be attributed to several possible sources of error. First of all, when calibrating the detectors, slight errors would have drastically affected the results. Detector B measures energy transmitted through the LEP and operates near the noise floor during high OD measurements. Fluorescence off the LEP could have altered the measurements. Also, when using LabVIEW, the precision of the measurements was often less than desirable (unnoticed until after readings were made). The readings could have been close to the noise floor of the detectors. This would have given incorrect energy readings. If all readings are correct, this data might suggest that the minor bleaching trend on the single pulse sample changed the physical or chemical properties of the sample. A change in





attributes of the sample could have produced unpredictable results in the 100 pulse readings.

"N1" was one of the two samples that showed physical damage from the laser. Multiple orange abrasions appeared on the surface of the LEP in the testing region. No similar abrasions were found on the unexposed area. The average width of the abrasions was about 6 microns. This sample increases in optical density versus energy on single pulses. With 100 pulses, this sample shows a minor decrease in optical density versus pulse number. The curve on the 100-pulse graph is fairly unreliable because of the wide point scatter. Many of the 100 pulse graphs revealed the same wide point scatter.

		Test Results per Sample			
		Increasing, Decreasing, or Static OD?			(Physical Change?)
sample	**Description**	**OD @ 800nm**	**Single Pulse**	**100 Pulse # vs. OD**	**Comments**
E	Grn plastic	5.00	decreasing	Increasing	major shift
G	Bg42 1mm	4.68	static	Static	glass samples
H	Bg42 2mm	6.96	static	Static	glass samples
K	Grn pl (visor type)	N/A	N/A	Increasing	
N1	Sample 1 - purp pl	8.55	static	Increasing	damage spots from laser
N2	Sample 2 - purp pl	8.71	static	Increasing	damage spots from laser
N3	Sample 3 - purp pl	7.93	static	Static	
N4	Sample 4 - purp pl	8.06	static	Increasing	
N5	Sample 5 - purp pl	4.80	decreasing	Decreasing	
N6	Sample 6 - purp pl	4.62	decreasing	Decreasing	
Q	Drk purp pl laser shield	6.72	decreasing	Static	
R	Brwn pl laser shield	5.04	increasing	Increasing	

These two data sets represent typical experimental results of all 12 samples. It also shows the trends of optical density versus pulse number at 100 pulses.

V. Conclusion

Samples "E", "N5", "N6", and "Q" showed decreasing optical density versus energy at single pulses. However, this decrease in optical density was not significant enough to qualify as bleaching. Samples "E", "K", "N1", "N2", "N4", and "R" showed an increase in optical density versus pulse number. Only "N1" and "N2" showed physical damage caused by the laser. The irradiance of our laser beam was significantly lower than that of other peoples' experiments that did experience bleaching. Our experimentation revealed more information on the topic of induced transmittance. A few of the samples showed a decrease in optical density versus energy, but no sample showed dramatic bleaching effects. Further research on this phenomenon is recommended with studies to compare irradiance levels. Hopefully, this type of research will lead to the creation of LEPs that can protect individuals from ultrashort pulses.

We give special thanks to the members of the Optical Radiation Branch of the Air Force Research Laboratory, Brooks AFB, for their support and insight. Especially Gary Noojin, Dave Stolarski, Major Gordon Hengst, and Dr. Benjamin Rockwell for their help in operating the femto–second laser system and assistance in data collection. Their guidance and assistance insured a successful experiment.

THE CONFIGURATION OF ANATOMICAL AND SEAT COORDINATE AXIS SYSTEMS

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Final Report for:
High School Apprentice Program
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, D.C.

and

Armstrong Laboratory

August 1998

THE CONFIGURATION OF ANATOMICAL AND SEAT COORDINATE AXIS SYSTEMS

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Abstract

In order to configure the Articulated Total Body (ATB) Model for a particular study, two groups of coordinate axis systems were determined. These included anatomical axis systems for the head and neck segments of the subject, and a seat axis system for the various seat planes found on the seat of the Horizontal Accelerator device located at the Wright-Patterson Air Force Base in Dayton, Ohio.

THE CONFIGURATION OF ANATOMICAL AND SEAT COORDINATE AXIS SYSTEMS

Kavitha K. Reddy

Introduction

The axis systems were configured for input into the Articulated Total Body (ATB) model. The ATB model is a whole body motion computer simulation program developed by the Armstrong Laboratory at the Wright-Patterson Air Force Base. It is used in the prediciton of three dimensional human body responses to the forces of ejection, aircraft, crashes, automobile accidents, and other hazardous environments. These forces are measured as G forces. Based on coupled rigid body dynamics analysis methods, the ATB model provides an evaluation of the effectiveness of various restraint and body support systems during multi-axis sustained and abrupt acceleration exposures. Test engineers often obtain data from the model that is used to supplement test results.

Methodology

The points used to establish the axis systems of the head and neck were chosen so as to create an x,y, and z axis, according to the anatomical axis system. In the anatomical axis system, when the head is facing forward, the y axis forms a horizontal line, positive in the left direction. The x axis runs straight forward, in the same direction as the eyes would look if they were looking straight ahead. The z axis forms a vertical line, perpendicular to the x and y axes and running through roughly the center of the head. The seat axes systems were configured according to the standard coordinate system, with each normal properly established. The seat of the Horizontal Impulse Accelerator (HIA) was used. The HIA powers a test sled on a 76 meter track using a 61 cm in diameter pneumatic piston. The acceleration proceeds by a programmed G level and duration. Biodynamic responses for any combination of X, Y, and Z axes may be obtained by rotation of the test fixture located on the sled. For all of the axis systems configured, both reference and axis points were established and each point was entered into the ATB model program using a digitizer probe.

Results

The relevant data points chosen for the anatomical axis systems follow:

Head Segment
Axis points
- Right tragion
- Left tragion
- Sellion
- Right infraorbitale

Reference Points
- Chin
- Brow
- Mouth Pack (bitebar)

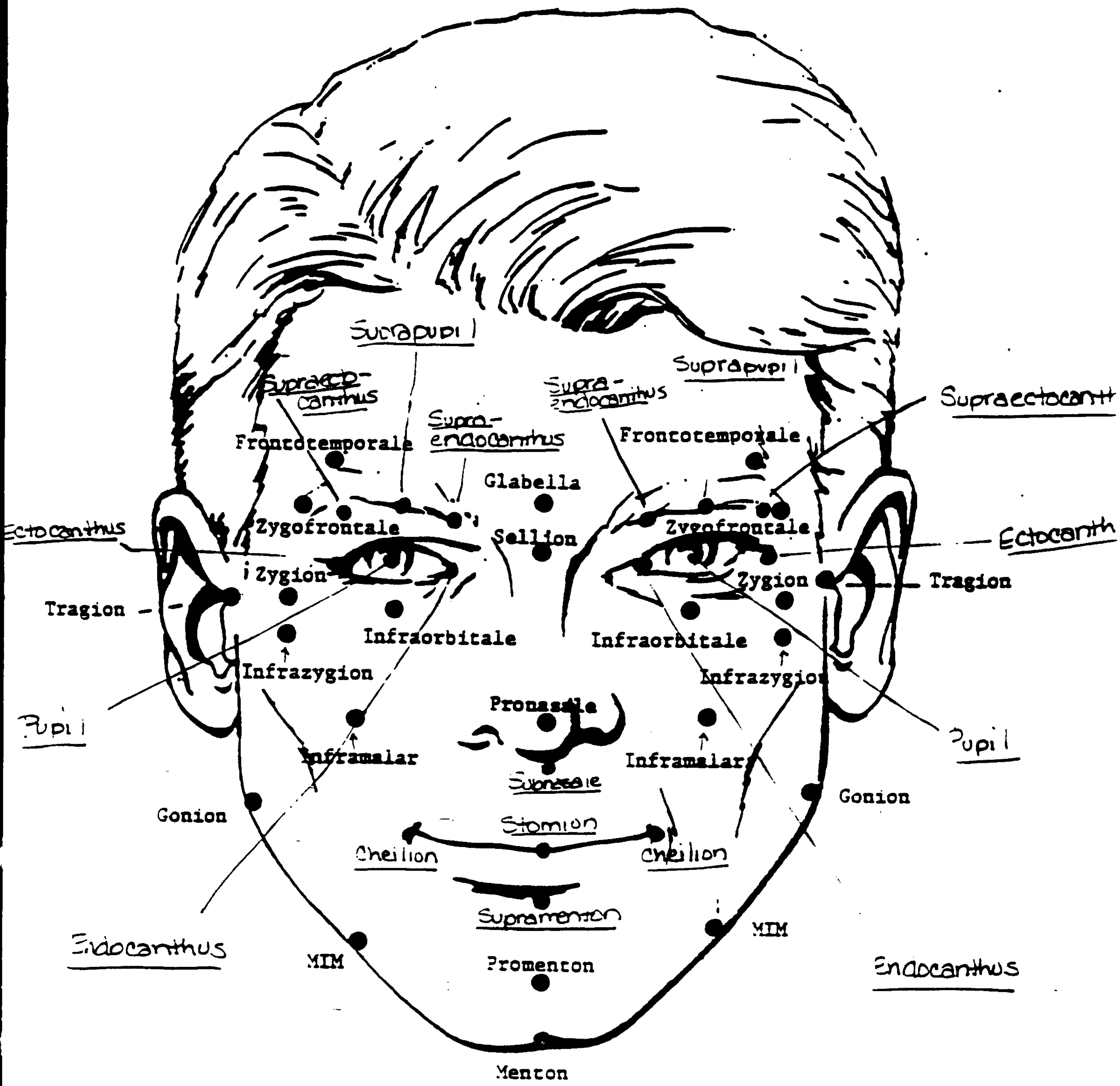
Neck Segment
Axis points
- Right clavicle/cervicale midpoint
- Left clavicle/cervical midpoint
- Adam's apple
- Cervicale

Reference points
- (none)

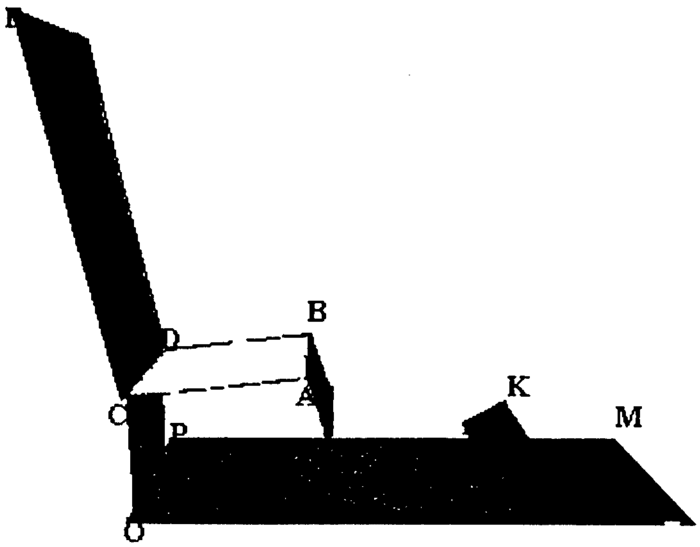
Thorax Segment
Axis points
- Suprasternale
- Mid spine at 10^{th} rib level

Reference Points
- Omphalion

The 42 Standard Landmarks: Front View



The nuchale and submandibular landmarks are not visible in this view.


B
D
K
A
C
M
P
O

Seat Points

Seat Cushion
- A Front Left
- B Front Right
- C Rear Left

Seat Back
- C Bottom Left
- D Bottom Right
- E Top Left

Floor
- P Front Left
- O Front Right
- M Rear Left

Rudder Pedals
- J Top Left
- K Top Right
- I Bottom Left

Seat Low Back
- O Bottom Left
- P Bottom Right
- C Top Left

Seat Front
- A Bottom Left
- B Bottom Right
- G Top Left

Conclusion

The anatomical axis system points may be defined as follows:

Tragion
The point located at the notch just above the tragus of the ear

Sellion
The point of greatest indentation of the nasal root depression

Cervicale
The protrusion of the spinal column at the base of the neck caused by the tip of the spine (q.v.) fo the seventh cervical vertebra

Adam's apple
The name given to the thyroid cartilage in men

Thyroid Cartilage
The bulge of the cartilage on the anterior surface of the throat

Suprasternale
The lowest point in the notch in the upper edge of breastbone

Omphalion
The center point of naval

The definitions were obtained from an antropometry source. Both the anatomical and seat axis systems were entered into the ATB model.

HYPERTEXT MARKUP LANGUAGE: AN INSTRUCTIONAL GUIDE FOR WEB PAGE DESIGN

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Final Report for:
High School Apprenticeship Program
AFRL/Armstrong Laboratory

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August 1998

HYPERTEXT MARKUP LANGUAGE: AN INSTRUCTIONAL GUIDE FOR WEB PAGE DESIGN

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Abstract

The programming language, HyperText Markup Language (HTML), was studied along with web page design. HTML, one of the major languages of the Internet's World Wide Web, is a user friendly, text based language that is used to create and modify web pages. After learning and studying the language, several web pages were designed to test the language and the Internet browsers. When the results of these tests were gathered, the findings were put into a simplified guide. The purpose of this guide is to instruct and guide the non-technical person who wants an easy tutorial on the HyperText Markup Language.

HYPERTEXT MARKUP LANGUAGE:
AN INSTRUCTIONAL GUIDE
FOR WEB PAGE DESIGN

William J. Squicciarini

Introduction

In recent years, the popularity of the Internet has exploded. On the World Wide Web, there is a web site for every interest. With over 40 million web sites, people are increasingly becoming familiar with the technology that brings the world to their computer screens. HyperText Markup Language (HTML) is the primary tool for bringing information together, via the Internet. As interest for the Internet expands, more people want to grasp that knowledge, learning the technology. Although there are numerous books and manuals available for HTML instruction, this manual is written for those non-technical people who want a basic, easy to follow tutorial.

Methodology

HyperText Markup Language (HTML) has been used in web design for several years. Its simplicity as a programming language has made it one of the most popular and understood tools of the World Wide Web. All that is required to fully comprehend the language is a little patience, a computer with a word processor and an Internet browser, and about six hours of free time. The first step taken in developing the HTML guide was to actually learn the language. Web tutorials and HTML books contained most of the data needed to start developing web pages. The remainder of the data came from testing the HyperText Markup Language on test pages that were developed as the language was being learned. Five such pages were developed. One page was for images, one page for text, one for hyperlinks, and two pages were made from using all of the elements. The last pages eventually became working web pages. When the testing was complete, the gathered data and findings were put into computer files, arranged by subject. The data in these files was then modified, edited, and further explained. Individual chapters resulted from these modified files. When all files had been reviewed, they were put together into an instructional guide. After creating a cover page, an introduction, table of contents, and an Appendix, the manual was proofread by several people. The completed and reviewed manual was then printed, put into a protective cover, and distributed to those who wanted it. Feedback from the users was positive.

Conclusion

In learning HyperText Markup Language, several benefits were gained. The knowledge of HTML learned while working for the Air Force Office of Scientific Research was given to others, so that they could broaden their own horizons and expand their knowledge. This knowledge allows the readers to be more independent, not having to rely on others for technical understanding. They can express their own individuality and creativity on the World Wide Web, without the help of others. The HTML guide accomplishes that.

References

While learning the basics of the HyperText Markup Language, several manuals and tutorials were used. Below is a list of them to which gratitude is owed:

Personal help:

Mr. Jose Torres-Reyes
and the
70th Communications Squadron
Small Computer Applications Training
Brooks Air Force Base, TX

HTML Tutorials and Reference Guides on the Internet:

http://www.davesite.com/webstation/html/

http://www.jmarshall.com/easy/html/

http://www.ncsa.uiuc.edu/General/Internet/WWW/HTMLPrimerAll.html

http://www.cc.ukans.edu/~acs/docs/other/HTML_quick.shtml

http://www.w3.org/MarkUp/Wilbur/features.html

http://junior.apk.net/~jbarta/tutor/makapage/index.html

http://werbach.com/barebones/barebone.html

HTML Instructional Manuals:

HTML 4 FOR THE WORLD WIDE WEB By: Elizabeth Castro